SEEDS

The Energy Literacy Series

Teacher's Guide 3

SRA

SCIENCE RESEARCH ASSOCIATES (CANADA) LIMITED
Toronto, Montreal, Chicago, Palo Alto, Sydney, Henley-on-Thames, Paris

SEEDS Foundation

EXECUTIVE DIRECTOR: Robert Westbury
PROGRAM DIRECTOR: Hugh Phillips

SEEDS 3

WRITING TEAM: Linda Davies, Dianne Arthur, Georgina Boulton, Judy Crewson
REVISION TEAM: Deanna Dahl, Phyllis Fleck, Elaine Gilchrist, Phyllis Jensen

SRA

EDITORIAL TEAM: Judith Reeves-Stevens, Karin Velcheff, Sherry Henderson, Joe Sobura
WRITER-CONSULTANTS: Elma and Robert Schemenauer
PRODUCTION COORDINATOR: Shelagh Roberts

DESIGN: Henning Christensen Graphics

ACKNOWLEDGMENTS:

Every effort has been made to identify and credit appropriately the sources of all copyright material used in this book. Any information concerning perceived errors or omissions will be appreciated, and the correct source acknowledged in subsequent editions.

Page 17 "The Mine" from *Miracles* copyright © 1966 by Richard Lewis.
Reprinted by permission of Simon & Shuster, a Division of Gulf & Western Corporation.

The metric usage in this text has been reviewed by the Metric Screening Office of the Canadian General Standards Board.

Metric Commission Canada has granted use of the National Symbol for Metric Conversion.

Copyright © Society, Environment & Energy Development Studies Foundation, 1981.
Published by Science Research Associates (Canada) Limited.

All rights reserved. Printed in Canada.

No part of this publication may be reproduced or transmitted in any form, including any storage or retrieval system, or by any means, electronic, mechanical, photographic, or recording, without permission in writing from the publisher, except as granted at publication for specified pages.

Printing History

1 2 3 4 5 6 7 8 9 0 90 89 88 87 86 85 84 83 82 81
Reorder No. 3-280431 **ISBN 0-574-09431-8**

CONTENTS

Preface 5

Introduction 6

Energy Literacy Objectives 8

Activity 1 Energy Everywhere 9
Activity 2 What are Fossils? What are Fossil Fuels? 11
Activity 3 Buried Sunshine: The Story of Coal 12
Activity 4 Mining for Coal 14
Activity 5 Buried Sunshine: The Story of Crude Oil and Natural Gas 17
Activity 6 Drilling for Oil and Natural Gas 21
Activity 7 Getting Fossil Fuels Ready for Use 24
Activity 8 Fossil Fuels and the Environment 27
Activity 9 Should We Extract Fossil Fuels? 30
Activity 10 Fossil Fuels are Nonrenewable 31
Activity 11 How Can We Use Fossil Fuels Wisely? 35
Activity 12 The Story of Sneakers 37
Activity 13 When in Doubt, Leave It Out! 39
Activity 14 Use Other Kinds of Energy If You Can 42
Activity 15 What Have You Learned About Fossil Fuels? 45

Scripts for Sound Filmstrips 47
Energy Everywhere
Energy from Fossil Fuels

Activity Sheets 50

Copyright © SEEDS Foundation, 1981. All rights reserved.

PREFACE

"Because our society is geared to living from day to day, it is difficult to recognize the long-term significance of events that are happening now. Even on major issues, we expect immediate action from our leaders, and we generally limit our own participation to reading the headlines.

But, in the next twenty to fifty years, the world will undergo massive changes in its supply and use of energy. In order to cope, we will have to alter lifestyles and expectations. We must recognize, too, that the greatest changes will occur during our children's lifetimes, and beyond ours. We will be shirking our responsibility unless we do everything possible to prepare the next generation for these social changes.

Society must stop forming its opinions about energy from headlines only. We must learn, and teach, the facts and encourage the most careful analysis of the issues. Emotionalism can only deter society from effective action."

Marshall Williams

Marshall Williams is a director and past president of SEEDS, the nonprofit foundation he was instrumental in establishing in May 1976. The acronym SEEDS identifies both the organization — Society, Environment & Energy Development Studies Foundation — and its offspring, the curriculum project now reaching published form.

From its beginning, SEEDS has worked toward its primary goal — to encourage the development of an "energy-literate" society, a society concerned about and committed to the wise use of energy.

The first task undertaken was the coordination of available human and material resources for energy and environment education, with the objective of developing twelve levels of curriculum materials for elementary and secondary school use. To accomplish this task, sixty educators, teams of 5 working at each level, immersed themselves in the wide range of materials made available to them, sifting and organizing the topics and issues into meaningful units of classwork appropriate to students' level of growth and understanding. Then, 150 teachers, with prior in-service training, tried out the study modules with more than 4000 students during the 1978-79 school year. Concurrently, a formal evaluation of these pilot units was undertaken by a team of professors of education. This class-testing and evaluation, combined with information and reviews provided by educators and personnel from energy-related industries and government bodies, provided guidelines for additional teams of teachers who then revised the materials.

Throughout, with the involvement of educators, environmentalists, business people, industry consultants, and government representatives,we have tried to achieve the presentation of balanced and objective educational modules that will help young people develop informed views of energy and the environment and act on them.

Our first years have been challenging, exciting, and rewarding. While there are many individuals to whom we extend our appreciation for helping to maintain this sense of purpose, one individual stands out as deserving of special thanks. Dr. Marshall Williams has been a constant source of leadership, encouragement, and most of all, vision.

Robert Westbury
Executive Director
SEEDS Foundation

Copyright © SEEDS Foundation, 1981. All rights reserved.

INTRODUCTION

The SEEDS Curriculum Project, produced and published by SRA, provides both student and teacher materials for a four- to six-week unit of study on energy-related concepts. It is designed to help teachers incorporate this topical material into their regular social studies and science curricula by providing a "guided discovery" approach suited to the students' level of growth and understanding.

Information on both the SEEDS Foundation and the history of the SEEDS Curriculum Project is given in the Preface. This Introduction outlines the organization of the curriculum materials.

The components for this Level include:

- a Teacher's Guide in a SEEDS binder
- a Professional Reference Guide
- a set of two sound filmstrips
- a 24-page Student Book

The *Teacher's Guide* provides information and guidelines, organized in a sequence of activities, for presenting the topics and carrying out the experiments, discussions, and other investigations. A description of the key elements of each activity follows.

STRUCTURE OF ACTIVITIES

Each activity begins with a summary of practical details, set out to assist the teacher in planning and preparation. Following this summary appear some or all of the sections entitled Core Activity, Extension(s), Enrichment(s), and Teacher Background.

Core Activity

This section provides a suggested procedure for the activity—whether it's a teacher presentation, an experiment, an audio-visual experience, or a discussion—to achieve the stated objectives.

Questions and Answers The questions embedded in the text or highlighted in boldface type are provided for you as a teaching aid, not as a script. Similarly, basic or possible answers (in whole or partial sentences) are provided when the progression of questions and answers is considered an integral part of the concept development. Do allow students adequate time, three or more seconds, to ponder before framing a response to these questions.

Experiments These are simple hands-on investigations of some of the basic concepts studied in this unit. They may be demonstrated by the teacher or carried out by the whole class. All materials are listed and should be readily available.

Use of Components Built into the procedure are suggestions for the appropriate introduction or use of the other components noted under the heading, **Materials**.

Extensions

This section provides a brief explanation or suggestion for one or more activities that will further develop the sub-topic and related social studies or science skills.

Enrichments

This section suggests activities that involve skills of other curriculum areas such as art, language arts, and music.

Teacher Background

Where a major or new concept is introduced, some background information is provided to reduce the need for teacher preparation. It usually takes the form of a brief summary of the basic scientific or technical concepts developed in the activity or a sequence of one or two activities.

Summary

Objectives The objectives are numbered sequentially from beginning to end of the unit, and are repeated for each activity to which they pertain. This Level's objectives are summarized on page 8; a summary of the six-grade span of objectives will appear in the Professional Reference Guide.

Time Since the time allotted to science and social studies within the curriculum varies widely from district to district, we have indicated the probable time for each section of the activity. The Core program will require four to six weeks, depending on how often you schedule science and social studies; the Extensions and Enrichments are not included in this estimate although probable times are noted.

Because of the nature of the topics and experiments, some activities may take longer than the usual time you allot to a lesson. Some activities, such as saving scrap paper, require preparations a few days in advance; these advance preparations are highlighted by a colored bar.

Vocabulary One aspect of "energy literacy" is the acquisition of the vocabulary with which to discuss concepts, topics, and issues. Of course, comprehension of the concepts is the ultimate goal, but the activities themselves are designed to develop that comprehension.

The vocabulary lists and definitions are provided for your information and for use at your discretion. It is preferable to provide a "handle" or name for a concept when the children themselves request it, having found new words necessary to describe the results of their experiments or the progress of their activities. However, the nature of the material sometimes requires that these words or definitions be introduced by the teacher. The vocabulary for each activity is presented on two levels—"oral vocabulary" and "reading vocabulary." The **Oral Vocabulary** lists contain those words that the teacher is to present and define, that is, that require aural/oral comprehension. Definitions of these words are usually provided in the body of the teacher text. The **Reading Vocabulary** lists contain those words that the children will encounter in their books or on the activity sheets. The main reference for placing words in the reading list has been the text *Basic Elementary Reading Vocabulary*, by Albert J. Harris and Milton D. Jacobson (Macmillan, 1972). Words listed therein as at or above the level were entered as reading vocabulary. Other words not in this text but required by the nature of the program are, of course, included.

Materials The items listed include other components for the level whether for student or teacher use. Special materials, not usually found in classrooms, are also listed.

Activity Sheets

Grouped at the end of this Teacher's Guide are the activity sheets which are designed to be used as black-line masters. On behalf of SEEDS Foundation, the copyright holder, SRA grants you, the teacher, the right to reproduce the activity sheets for classroom use. They are numbered sequentially and include a key to the activity number and level. Where possible, answers are provided for you in the text of the Core Activity. An **Energy Folder**, as suggested at the end of the first activity, can be prepared by the students for storing all the work they produce during this unit of study.

Sound Filmstrips

The scripts for the filmstrips required for this level are printed on pages 47–48. They are printed primarily as an aid to your preparation, a reminder of what you previewed or showed previously in class and may vary slightly from the taped version. The cassette tape contains two recordings of the script, one for automatic advance of the frames (with an inaudible tone), one for manual advance (with an audible tone).

Student Book

The Student Book serves as a base of reference for the major topic presented in the level. It provides a focus of interest for some group or class discussions. The colorful illustrations, whether photographic or artwork, have been selected to help students visualize and comprehend the elements of their study.

Copyright © SEEDS Foundation, 1981. All rights reserved.

ENERGY LITERACY OBJECTIVES

The objectives, stated in terms of learning outcomes expected for the students, draw on energy-related concepts from the social sciences, the natural sciences, and the physical sciences.

1. Define the word *energy*.
2. Recognize some common sources and uses of energy.
3. Recognize that the sun is the most important source of natural energy.
4. Recognize the basic concept of conservation (saving through wise use).
5. Recognize that fossil fuels provide most of the energy used in our community today.
6. Recognize that fossil fuels are energy from the sun, stored in the bodies of plants and tiny animals that died millions of years ago.
7. Recognize that fossil fuels must be extracted from the ground before they can be used.
8. Examine processes for extracting coal.
9. Recognize that fossil fuels are found in three forms: solid (coal and oil sand), liquid (crude oil), and gas (natural gas).
10. Examine the processes for extracting crude oil and natural gas.
11. Recognize that fossil fuels must be prepared and changed in various ways before people can use them.
12. Identify some uses and products of fossil fuels.
13. Identify good and bad effects of extracting fossil fuels.
14. Distinguish between renewable energy sources (such as wind, water, and wood) and nonrenewable energy sources (such as coal, oil, and natural gas).
15. Recognize that the earth's supply of fossil fuels is limited.
16. Give examples of how we can use fossil fuels wisely.
17. Distinguish between needs and wants.
18. Identify ways in which we can save fossil fuels by using only those machines, appliances, and products that we really need.
19. Recognize that the use of fossil fuels and their products can affect the environment in serious ways.
20. Identify ways of using alternative sources of energy, especially energy from food.
21. Recall and review the concepts presented in this module.

Activity 1
Energy Everywhere

OBJECTIVES

1. **Define the word *energy*.**
2. **Recognize some common sources and uses of energy.**
3. **Recognize that the sun is the most important source of natural energy.**
4. **Recognize the basic concept of conservation (saving through wise use).**
5. **Recognize that fossil fuels provide most of the energy used in our community today.**

Preparation Time	**Instruction Time**	**Oral Vocabulary**	**Reading Vocabulary**
Core: 20 min Enrichment: 10 min	Core: 25 min Enrichment: 35 min (flexible)	coal, natural gas, oil	energy, energy source

Materials

Each child will need: Student Book and a notebook / pencil.

You will need: Filmstrip and cassette, *Energy Everywhere*, and a projector / screen.

TEACHER BACKGROUND

Although everything we do requires energy, the sources of this energy vary. Energy is available from renewable sources — wind, water, and biomass — and from nonrenewable sources — coal, oil, and natural gas.

In some cases, we use the energy source directly, such as the use of wind energy to propel a sailboat or the energy from oil or gas to heat our homes. In other situations, one form of energy is converted to another form that can be used. For example, the heat energy from burning coal can be used to generate electricity. This electricity can then be used to power an electric heater, a drill, or any other electric appliance or machine.

Energy sources can be classified as either renewable or nonrenewable. Nonrenewable sources are those that can be exhausted. The fossil fuels — oil, coal, and natural gas — are all in this category. Uranium is also a nonrenewable source of nuclear energy.

Our dependence on fossil fuels is relatively recent. In 1860, only 5% of the energy used in the world came from fossil fuels; the remaining 95% came from the muscles of people and domestic animals. Now the opposite is true.

CORE ACTIVITY

For children familiar with the SEEDS program, this opening activity with the filmstrip, *Energy Everywhere*, is an integration of concepts learned in Levels 1 and 2. These children will know the vocabulary words and the concepts denoted by them. Instead of a discussion based on these concepts as they are introduced by the filmstrip, you might like to show the film twice. Show it the first time straight through with the narration as a general reminder of topics studied earlier. Then run it a second time without the narration, and call on individual children to supply the commentary.

For children who are beginning the SEEDS program, this opening activity with the filmstrip introduces them to the concepts of what energy is, the sources of energy used by society today, and the environmental and societal problems of our energy use.

Show the filmstrip, *Energy Everywhere*. After you have shown the filmstrip,

Copyright © SEEDS Foundation, 1981. All rights reserved.

discuss it with the children, using questions similar to the following:

What is energy? Energy is "go-power" or the ability to do work.

How do people and animals use energy? People and animals use energy to run, jump, think, breathe, eat, grow, stay alive, . . .

How do plants use energy? Plants use energy to grow, stay alive, produce flowers, produce seeds, . . .

Where do people and animals get their energy? People and animals get their energy from food.

Where do plants get their energy? Plants get their energy from the sun. They also need air, water, and soil to grow and to stay healthy.

In what important way are machines different from people, animals, and plants? Machines are not alive.

How do machines use energy? Machines use energy to do work for people. Some machines carry people from one place to another. Some clean floors. Some keep people warm. Some cut grass. Some dig holes. . . .

Where do machines get their energy? Some machines get their energy from gasoline. Some machines get their energy from electricity.

What does the sun's energy do for people, animals, and plants? It helps keep them warm, gives them light, gives plants energy to make their own food, helps to make rain fall on the earth, . . .

Where does our food energy come from? From eating plants and animals.

What is the single most important thing in the production of our food? The sun. It makes plants grow. Some animals eat these plants. People eat the plants, too. Some people also eat animals that have eaten plants.

How can we save energy from oil, gasoline, and electricity? We can ride bicycles instead of riding in cars, use public transit instead of riding in cars, put on sweaters instead of turning up the furnace, . . . In many cases, we can use our own energy to do things instead of using energy from gasoline, oil, and electricity.

Now have the children turn to page 3 of their Student Books. Point out the title *Energy Everywhere*. Have the children look at the picture and answer, in their notebooks, the questions at the bottom of the page. The questions and possible answers are:

1. How is energy being used in this picture? The motorcycle is using energy to move. The woman pushing the lawnmower is using energy to push the lawnmower. The lawnmower is using energy to cut the grass. The girl is using energy to rake the grass. The children are using energy to play.

2. What sources of energy do you see in the picture? Oil in the oil truck; natural gas in the pipes under the street; the sun in the sky; the wind blowing; the water moving in the gutter.

3. Which of these sources of energy are being used the most by the people in the picture? Oil, gasoline, and natural gas.

ENRICHMENT

Art Make an Energy Folder Have the children look in old magazines, catalogues, and similar sources for pictures relating to coal, oil, and natural gas. For example, they might find pictures of coal mines, of big machines used in coal mining, of derricks and other equipment used in the extraction of oil and natural gas, of stoves and furnaces that burn coal, oil, or natural gas, . . .

Have each child cut out and paste his / her collection of pictures on a large sheet of paper that, when folded in half, can serve as a folder to hold completed activity sheets. Have the children print or write the word *energy* as a title on their folders.

Activity 2
What are Fossils? What are Fossil Fuels?

OBJECTIVE **6. Recognize that fossil fuels are energy from the sun, stored in the bodies of plants and tiny animals that died millions of years ago.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 20 min Extension: 10 min Enrichment: 10 min	Core: 30 min Extension: 30 min Enrichment: 30 min	crude oil, flesh, fossil(s), fuel, mammoth, sap, shellfish, tusk(s)

Materials Each child will need: Student Book and a notebook / pencil.

CORE ACTIVITY

In the previous activity, the children learned that coal, oil, and natural gas are the source of energy that we use the most. In this activity, they will learn what a fossil is, and why we call coal, crude oil, and natural gas the fossil fuels. If you feel that some children will have trouble with the Reading Vocabulary words, put them on the board and make sure all children can read and understand them. Then have them read the story on Student Book pages 4 and 5.

When the children have finished the reading, have them answer the questions that follow the text in their notebooks. Children's answers will vary. Most may take the form of the following:

1. What are fossils? Fossils are the prints or the bodies of plants and animals that lived and died millions of years ago.

2. Where are fossils found? They are usually found in rock, either deep underground or close to the surface.

3. Why do you think coal, crude oil, and natural gas are called the fossil fuels? Because they are found in rock, under the ground; because they are the remains of plants and tiny animals that died millions of years ago; and because we burn them to get energy.

When all the children have finished, have them share their answers in a class discussion.

EXTENSION

If there is a fossil-rich area near you, take the children on a field trip to observe fossils at first hand. Even if the fossils are very plentiful, specify that the children are not to take them away from the area, but are to examine them where they are. If you are unable to show the children any fossils in a natural setting, investigate the possibilities of taking them to a museum where fossils are on display.

ENRICHMENT

Art Make a Fossil Model Have the children make fossil models by pressing leaves, other plant materials, and / or shells into wet clay or mud. After the objects have been removed and the clay or mud has dried, the effect will be similar to fossil prints in rock.

Copyright © SEEDS Foundation, 1981 All rights reserved

Activity 3
Buried Sunshine: The Story of Coal

OBJECTIVES

3. **Recognize that the sun is the most important source of natural energy.**
6. **Recognize that fossil fuels are energy from the sun, stored in the bodies of plants and tiny animals that died millions of years ago.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 25 min	Core: 45 min	coal, pack(ed)

Materials

Each child will need: Student Book, Activity Sheet 1, and a notebook / pencil.

You will need: a piece of firewood (log), a lump of coal, and fossils or pictures of fossils.

TEACHER BACKGROUND

Existing coal deposits are the remains of plants that grew some hundreds of millions of years ago. As they accumulated and were covered over, these plants first turned into peat and later, under the pressure of gradually accumulating sediments, into coal. The greater the pressure and the longer it lasted, the higher became the grade, or rank, of coal. Lignite is the lowest grade of coal, bituminous is the middle, and anthracite is the best and cleanest burning.

There are a number of important coal fields in North America. The Appalachian fields and the deposits in Illinois, Kansas, Michigan, and the maritime provinces of Canada contain bituminous coal. The world's chief anthracite field is in eastern Pennsylvania, while more anthracite in addition to low-ranking coal is found in the Rocky Mountain area as well as regions in the province of Alberta. The U.S.A. is the world's second largest producer of coal. The U.S.S.R. ranks first.

CORE ACTIVITY

Provide the children a piece of wood (a log) and a lump of coal. Have them handle these objects, noting their colors, relative hardnesses, and so on. Then ask:

Can you think of any ways that wood and coal are alike? Both are sources of energy; both are fuels.

Where do you think wood comes from? Trees.

Where do you think trees get energy to grow and make wood? From the sun.

Where does coal come from? Discuss this question. Some children will know that coal comes out of the ground. Tell the children you are going to read them a story. Have them turn to Student Book page 6 and follow the numbered pictures as you read:

The Story of Coal

Picture 1. Millions of years ago, many large, tree-like, green plants grew in a great swamp near an ocean. The weather was warm and wet, so the plants grew quickly. They used the sun's energy to make their own food.

Picture 2. Whenever a plant died, it would fall into the waters of the swamp. As time

passed, other plants fell on top of it. Mud and sand covered the dead plants. Then more plants fell into the water only to be covered by more mud and sand.

Picture 3. As millions of years passed, the earth moved and changed. Oceans came and went. More dead plants fell, and more mud and sand came in. The dead plants and mud and sand in the bottom layers were packed more and more tightly together.

Picture 4. The mud and sand were packed and pressed so tightly together that, after a long time, they changed into rock. The layers of dead plants were packed and pressed tightly, too. They became hard and dark looking. As the years passed, they became harder and harder and blacker and blacker until at last they became coal.

Have the children observe the lump of coal again. Have them tell you how it feels, how it smells, and what color it is. Children could record these observations in their notebooks or on the back of Activity Sheet 1. Then, have them answer the questions on Student Book page 6. The questions and possible answers are:

1. What is coal made of? Green plants that died millions of years ago.

2. How did coal get into the ground in the first place? Plants fell into swamps, were covered with mud and sand, were packed tightly together, and slowly became harder and blacker until they formed coal.

When all the children have finished, have them share their answers in a class discussion.

Now, say:

Some people say coal is "buried sunshine." What do you think this means? Discuss the question, leading the children to realize that coal started out millions of years ago as large, tree-like green plants. These plants used the sun's energy to live and grow and make their own food. Therefore, when we burn coal as a fuel today, we are really using energy from the sun that was stored and buried millions of years ago. Have the children look back at the fossil pictures on Student Book page 4. Remind them that fossils are the prints or the bodies of plants and animals that lived millions of years ago. These fossils are often preserved in rock. Then ask:

Why do you suppose we call coal a fossil fuel? Because it is made up of plants that died millions of years ago; because these plants have been preserved in rock; and because we burn coal to get energy.

Distribute Activity Sheet 1. Have the children complete the story of the formation of coal. If they need help, you may wish to have them refer to the pictures in the Student Book as a guide.

Copyright © SEEDS Foundation, 1981. All rights reserved.

Activity 4
Mining for Coal

OBJECTIVES

7. **Recognize that fossil fuels must be extracted from the ground before they can be used.**
8. **Examine processes for extracting coal.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 15 min Extension: 20 min Enrichment: 10 min	Core: 35 min Extension: 50 min (flexible) Enrichment: 15 min	blast(ed) (ing), elevator(s), machine(s), mining, seam(s), shaft(s), shuttle, strip, surface, topsoil

Materials Each child will need: Student Book, Activity Sheet 2, and a notebook / pencil.

TEACHER BACKGROUND

Coal is mined either underground or on the surface depending on the inclination, thickness, and depth below the surface of the coal beds, or seams. Coal seams are found lying on their sides, upright, or at any angle inbetween. The steepest-angled seams occur in mountainous areas, whereas coal seams found under prairies are flat or nearly so. Seams vary in thickness from a few centimetres to fifteen metres. Coal seams can occur on the surface of the land and anywhere below the surface.

In underground mines, coal that lies deep beneath the ground is reached by steeply sloping or vertical openings called *shafts*. Most underground mines require at least two shafts for ventilation purposes. One shaft is also used for bringing coal to the surface and transporting workers and equipment. Tunnels branch out from shafts, and it is in these tunnels that coal is cut from seams by miners or by machines. The coal is carried by elevators, conveyor belts, or shuttle cars to the surface. There it is cleaned and sorted according to size before being sent on its way.

Coal near the surface of the earth is recovered by surface, or strip, mining. Before the stripping is begun, information is obtained on the topography of the area, depth of the coal, thickness and grade of the coal seam, and nature of the overlying rock, or *overburden*. Coal is generally strip mined when it is no more than 45 m from the surface of the earth.

Large power shovels, called *draglines*, and bulldozers strip the overburden and move it to a waste pile. The coal seam is blasted into pieces. Then, smaller power shovels are used to remove the coal, which is hauled out of the pit by large trucks to be cleaned and sorted before moving on to its destination.

Most of the coal mined in North America is used in the production of electricity and to make coke, which is commonly used to refine iron ore.

CORE ACTIVITY

Have the children look at Student Book page 7. Have them examine the first pair of illustrations, noting that coal is found at different depths within the earth.

Write the word *surface* on the board. Elicit from the children that it means "top." Make sure all children can read the word. Then, write the word *seams* on the board and make sure the children understand it and and can read it. (The word has a more common meaning related to sewing, but in this case it refers to layers of coal). Then ask:

Can people use coal the way we see it in these pictures? No.

What is the first thing that people must do before they can use coal for energy? Take it out of the ground.

Have the children look at Student Book page 7 which illustrates one method of taking coal out of the ground by strip mining. Have individual children read the caption that goes with each picture.

Picture 1. Sometimes coal is found close to the surface of the earth. Sometimes it is found deep underground. Layers of coal are called *seams*.

Picture 2. If the coal is close to the surface, big machines scrape away the topsoil and rock. This uncovers the coal seam.

Picture 3. Holes are drilled into the coal seam. Then, it is blasted into pieces.

Picture 4. Smaller machines pick up the coal and rock. They load it into trucks.

Write the words *machine*, *coal seam*, *topsoil*, and *blasted* on the board and make sure all children can read and understand them.

Now have the children answer the questions on Student Book page 7 in their notebooks or on the back of Activity Sheet 1. The questions and possible answers are:

1. What is the machine doing in picture 2? Scraping away the topsoil.

2. What is uncovered? A coal seam.

3. What happens next? Holes are drilled into the coal seam. Then, it is blasted into smaller pieces.

4. What is the machine doing in Picture 4? The shovel is loading coal and rock into a truck.

When all the children have finished, have them share their answers in a class discussion. Then ask:

What happens when coal seams are deep under the ground? Can people use strip mining to take out the coal? No, because there would be too much topsoil and rock to remove.

Do you know what method is used for mining deep coal seams?

Probably some children will know that deep holes, or *shafts*, are dug in order to reach the coal seams. Have them look at Student Book page 8, which shows one method of shaft mining. Again, have individual children read the captions to the class.

Picture 1. Deep holes, called *shafts*, are dug to reach coal seams that are deep underground.

Picture 2. Down in a shaft mine, machines cut and blast the coal loose from the seams.

Picture 3. Then machines scoop up the lumps of loosened coal.

Picture 4. Shuttle cars carry the coal to the shaft. The coal is lifted to the surface by elevator.

Write the words *shaft*, *shuttle cars*, and *elevator* on the board, making sure that children can read and understand them. After the children have studied the pictures and captions for a few minutes, have them answer the questions on Student Book page 8 in their notebooks or on the back of Activity Sheet 1.

The questions and possible answers are as follows:

1. What are *shafts*? Why are they dug? Deep holes in the earth. To reach coal that is deep underground.

2. What is the machine doing in picture 2? Scooping up the loosened coal.

3. What are the shuttle cars doing? Taking the coal to the mine shaft.

4. How does the coal get to the surface? Lifted by elevator.

Copyright © SEEDS Foundation, 1981. All rights reserved

When all the children have finished, have them share their answers in a class discussion. Then distribute Activity Sheet 2. Have the children label the parts of a shaft mine with the words provided.

EXTENSION

Have the children construct a working model illustrating the process of strip mining. It could be made in a sandbox or in a large cardboard box. Have the children suggest and discuss what materials they might use. Toy machines can be used to represent the machines used in strip mining. Use layers of soil, sand, rocks, and real coal, if possible. If you cannot obtain coal, paint some rocks black to represent coal.

ENRICHMENT

Poetry Read the following student-written poem to the children, or write it on the board for them to read.

The Mine

Here are we; in the darkness,
Close to the very heart of Mother Earth,
Where her blood flows in seams of shining coal,
And our picks beat a rhythm to her heart,
Where her warm brown flesh encloses us
And her rocky bones trap us.

To further the children's understanding and appreciation of the poem, discuss it by means of questions such as:

What name does the poet give to the earth? Mother Earth.

What does the poet say Mother Earth's blood is? Seams of shining coal.

What do you think the poet means by the words, "her warm brown flesh?" The soil.

What does the poet mean by the words, "her rocky bones?" Underground layers of rock.

The people in the poem are using heavy, sharp-pointed tools called picks to break the coal loose from the seam. Picks are hand tools.

Ask:

What do people usually use now to break the coal loose? Machines.

Activity 5
Buried Sunshine: The Story of Crude Oil and Natural Gas

OBJECTIVES

3. **Recognize that the sun is the most important source of natural energy.**
6. **Recognize that fossil fuels are energy from the sun, stored in the bodies of plants and tiny animals that died millions of years ago.**
9. **Recognize that fossil fuels are found in three forms: solid (coal and oil sand), liquid (crude oil), and gas (natural gas).**

Preparation Time	**Instruction Time**	**Oral Vocabulary**	**Reading Vocabulary**
Core: 30 min	Core: 55 min	refine(ed)	body(ies), experiment, fold(ed), nonporous, ocean, oil sand, porous, seep(ed), solid, sponge-like

Materials

Each child will need: Student Book, Activity Sheet 3, and a notebook / pencil.

You will need: a sample of crude oil (If crude oil is unavailable, use some or all of the following: motor oil (for cars), diesel fuel, or furnace oil.); a very porous (sponge-like) rock, brick, or building block; a nonporous (dense) rock, or a glazed tile, or a plate; a spoon.

TEACHER BACKGROUND

Crude oil ranges in color from yellow to brown to bluish-brown to black. It may be as easily poured as water, or be as thick as very heavy cream. Crude oil is a mixture of compounds that contain mostly hydrogen and carbon atoms. Natural gas, which is also a hydrocarbon, is often found in the same area as crude oil. Natural gas is an invisible, tasteless, odorless gas. For safety reasons, chemicals are usually added in order to give it an odor.

Both crude oil and natural gas were formed hundreds of millions of years ago from the bodies of tiny sea animals and the remains of small sea plants. The animal and plant material was built up in layers on the sea floor. Sand, mud, and other sediments covered it. With pressure and heat and the passage of time, the animal and plant material slowly changed into crude oil and natural gas.

Crude oil and natural gas are often found along with salt water in underground "traps." The oil and gas are contained in porous rock formations. Under some circumstances they easily seep through such formations, often traveling considerable distances. However, when they are in "traps," their movement has been stopped by surrounding layers or domes of impenetrable rock.

Oil sand is the name given to a geological deposit in which sand, water, and bitumen are found together. Each grain of sand is surrounded by a thin film of water which in turn is surrounded by bitumen.

Many substances can exist as gases, liquids, and solids. These three conditions of substances are referred to as *states*. The particular state is uniquely determined by the substance itself, and the temperature and pressure acting on the substance. In everyday life, we are perhaps most familiar with the three states of water caused by falling or rising temperatures: ice (solid), water (liquid), and water vapor (gas).

Fossil fuels may be found in these three forms. Coal and oil sand are solid fossil fuels. Crude oil is a liquid fossil fuel. Natural gas is a fossil fuel generally found as a gas, but it is capable of being changed into a liquid for storage purposes.

Copyright © SEEDS Foundation, 1981 All rights reserved

CORE ACTIVITY

Have the children look at Student Book page 6. Have them briefly tell you about the pictures, reviewing the story of the origin of coal. Then have them look again at the fossils on Student Book page 4. Ask them to tell you why we call coal a *fossil fuel*.

Why do you think we call crude oil, natural gas, and oil sand, fossil fuels? Allow the children to speculate briefly. Some of them may realize that the history of these substances may be similar to that of coal since they are all called fossil fuels.

Write the terms *crude oil*, *natural gas*, and *oil sand* on the board and make sure the children can read them.

If you have been able to obtain samples of crude oil, show them to the children at this time, having them note the color, smell, thickness, and so on. Elicit from them that it is called "crude" because it has not been cleaned or "refined" yet in order to be used in cars, trucks, furnaces,... It is just as it came out of the ground. Natural gas is "natural" for the same reason. It needs to be refined before it can be used.

If you do not have samples of crude oil, show the children some of its refined products: motor oil, diesel fuel, and / or furnace oil.

Now, tell the children that you are going to read a story about crude oil and natural gas. Have them turn to Student Book page 9 and follow the numbered pictures as you read:

The Story of Crude Oil and Natural Gas

Picture 1. Millions of years ago much of the earth was covered by shallow (not very deep) oceans. Many tiny animals lived in the oceans. They fed on sea plants that used the sun's energy to live and grow.

Picture 2. When the tiny sea animals died, they sank to the ocean floor. The dead sea plants also drifted to the bottom. Mud and silt (very fine sand) covered both the animals and plants. Then more tiny animals and plants sank to the bottom, only to be covered by more mud and silt.

Picture 3. As time passed, the earth moved and changed. The layers of sea animals and plants, and of mud and silt got pressed more and more tightly together. At last the mud and silt turned to rock. The bodies of the sea animals and plants slowly changed, and at last turned into crude oil and natural gas.

Picture 4. Some of this crude oil and natural gas seeped into rocks that had many tiny holes in them. In this way, the crude oil or natural gas sometimes traveled a long way, seeping from one sponge-like or porous, rock to another.

Write the words *porous*, *sponge-like*, *nonporous*, and *seeped* on the board and make sure the children can read them.

Picture 5. However, some kinds of rock are very solid. They don't have any little holes in them. When the crude oil and natural gas reached a layer of rock like this, they had to stop, they were trapped. Sometimes this happened when the earth moved, making the layers of rock fold and bulge up. A layer of porous rock might end up under a layer of solid rock. When this happened, any oil and natural gas in the porous rock was trapped. (If your class is having difficulty with the idea of rock folding and bulging, make a model of layers of differently colored Plasticene and show the class how layers can fold.) This folded rock is called an *oil trap*.

Write the words *solid rock* and *oil trap* on the board and make sure the children can read them.

Picture 6. Oil sand was formed when crude oil came out of the earth and soaked into sand.

When you have finished reading the story, have the children answer the questions on Student Book page 9 in their notebooks or on the back of Activity Sheet 2. The questions and suggested answers are:

1. What are natural gas and crude oil made of? The bodies of tiny animals and plants that died millions of years ago.

2. How did crude oil and natural gas get into the ground in the first place? They were formed when oceans covered much of the earth; tiny animals and plants fell to the ocean floor, were covered by mud and silt, and slowly changed into crude oil and natural gas.

When all the children have finished, have them share their answers in a class discussion.

If you have not covered solids, liquids and gases in your core science program, you might like to do so now. If you have discussed states of matter, ask your class:

How can you describe crude oil? Is it a liquid, a solid, or a gas? Is oil sand a liquid, a solid or a gas? Is natural gas a liquid, a solid, or a gas? Do you think that there could be three forms of the same thing — like water which can be liquid, solid, or gas? Have children discuss the questions.

You could then say:

Some people say crude oil and natural gas are "buried sunshine." What do you think this means?

Discuss the question. Lead the children to realize that crude oil and natural gas started out millions of years ago as plants (which used the sun's energy to produce their own food) and animals (which fed on the plants that in turn depended on the sun's energy).

Have the children look at the pictures on Student Book page 10. The pictures show an experiment being performed. Ask the children if they know what the word "experiment" means ("a test done to find out").

To begin the experiment, have individual children observe the porous rock (or brick or building block) and the nonporous, dense rock (or glazed tile or plate) and have the class describe what they see, feel, and smell. Make sure that they observe the numerous holes in the porous rock and the absence of holes in the nonporous rock.

Now measure out some of the oil you used in the demonstration at the beginning of the activity. Slowly let the oil drip onto the porous rock. Have individual children tell the class what they observe.

Now, do the same with the nonporous rock, again having individuals tell the class their observations. Now have the children answer the questions on Student Book page 10 in their notebooks or on the back of Activity Sheet 2.

The questions and possible answers are:

1. Did the oil go into the brick (porous rock)? Yes, it did.

2. Did the oil go into the tile (nonporous, solid rock)? No, it did not. It ran off.

3. Crude oil often moves long distances from the place where it is formed. How? It seeps from one porous rock to another.

4. How does crude oil sometimes become trapped? It reaches a layer of rock that is very solid, not porous, and can go no farther.

Copyright © SEEDS Foundation, 1981 All rights reserved

Now have the children chart their observations in their notebooks on a chart similar to this one:

	Holes	No Holes	Oil Went In	Oil Ran Off
Porous				
Nonporous				

Distribute Activity Sheet 3. Have the children use the words to fill in the blanks and complete the crossword puzzle. Assist any children who do not understand how a crossword puzzle works.

Questions and answers are:

1. Millions of years ago many tiny sea animals and plants sank to the bottom of the ocean. (1 ACROSS)
2. Mud and fine sand covered them. (3 ACROSS)
3. As the earth shifted and changed, the layers were pressed more and more tightly together. (2 DOWN)
4. At last the mud and fine sand turned to rock. (4 DOWN)
5. The bodies of the sea animals and plants slowly turned into crude oil and natural gas. (5 DOWN)
6. The crude oil and natural gas often seeped into rocks that had many tiny holes in them. (6 ACROSS)
7. But whenever the crude oil and natural gas reached solid rock, they stopped. They were trapped! (7 ACROSS)
8. Today, people who drill for oil often find crude oil, natural gas, and water together under a folded layer of solid rock. (8 DOWN)

Activity 6
Drilling for Oil and Natural Gas

OBJECTIVES

7. **Recognize that fossil fuels must be extracted from the ground before they can be used.**
9. **Recognize that fossil fuels are found in three forms: solid (coal and oil sand), liquid (crude oil), and gas (natural gas).**
10. **Examine the processes for extracting crude oil and natural gas.**

Preparation Time
Core: 25 min
Extension: 15 min

Instruction Time
Core: 50 min
Extension: 40 min (flexible)

Reading Vocabulary
derrick, drill bit, drilling rig, engine(s), powerful, pump(s), raise(s) (ed) (ing), scientist(s)

Materials

Each child will need: Student Book, Activity Sheet 4, and a notebook / pencil.

You will need: clear glass jar with tight-fitting lid, marbles to fill the jar, water, crude oil (or a substitute such as heating oil, motor oil, or cooking oil).

TEACHER BACKGROUND

Oil drilling operations begin with exploration, during which complex scientific data is collected and analyzed to select a probable site. Once the location is chosen, a road is constructed and a tower, or derrick, is erected to support, raise, and lower the many lengths of drill pipe needed to bore a typical well.

The drill pipe has a special cutting edge, the drill bit, capable of cutting through hard rock on its way to the deposit. A mixture of water, clay, and chemicals — called drilling mud — is continuously pumped down through the middle of the hollow drill pipe to lubricate and cool the bit. The drilling mud also flushes chips of broken rock to the surface. As the hole is cut and deepened, it is lined with a steel pipe for support.

Once the oil deposit is reached, the drilling operation ceases and is replaced by a pumping operation to get the oil to the surface.

Sometimes the pressure of the natural gas and water is enough to drive the oil up the pipe, but usually this forces out only a small portion.

More oil can be recovered by direct pumping, or even more effectively, by a sophisticated technique called "huff and puff." Two or more wells are required with this method in which water or steam is injected in one or more of the wells and the pressure forces the oil up through another well. In situations where the oil is very thick, steam is more successful because the heat reduces the viscosity, or thickness, of the oil, permitting it to flow much more easily. In spite of these advanced techniques, no more than 25% of the reserve is extracted at many oil fields.

CORE ACTIVITY

In the previous activity, the children learned that natural gas, crude oil, and water are often found together in an underground oil trap.

In this activity, you will be making a classroom model that will help the children understand oil traps better. Show children the glass jar. Fill it with marbles.

Ask the children:

If this is a model of an oil trap, what do you think the marbles stand for?
Porous rock.

Copyright © SEEDS Foundation, 1981 All rights reserved.

Next, fill the jar to the one-third level with water. Then pour in oil to the two-thirds level. Put the lid on and shake the jar thoroughly. Set it down and watch the oil separating from the water and rising to the top.

Ask:

What do you think the oil in the jar stands for? Crude oil in an underground trap.

What do you think the water in the jar stands for? Water in an underground trap.

Which is lighter — the oil or the water? The oil.

How do you know? It rose to the top.

Now have the children look at the top third of the jar. Ask them what is in it. If necessary, lead the children to realize that the top third of the jar contains not only marbles but also air. Tell them that air is a gas (like water vapor).

Ask:

What does the air in the jar stand for? Natural gas in an underground trap.

Which is lightest — oil, water, or gas? Gas.

How do you know? It rose to the top.

Which is heaviest — oil, water, or gas? Water.

How do you know? It sank to the bottom.

Now have the children look at the top third of the jar. Ask them what is in it. If necessary, lead the children to realize that the top third of the jar contains not only marbles but also air. They might have seen bubbles of air rising through the liquid after the jar was shaken. Tell them that air is a gas (like water vapor).

Now have the children answer the questions on page 11 in their notebooks or on the back of Activity Sheet 3.

The questions and possible answers are:

1. **What does the water stand for?** The water in an oil trap.
2. **What do the marbles stand for?** The sponge-like or porous rock in an oil trap.
3. **What does the oil stand for?** The crude oil in an oil trap.
4. **What does the air stand for?** The natural gas in an oil trap.
5. **What does the glass jar stand for?** The solid rock.

When all the children are finished, have them share their answers in a class discussion.

Now ask:

Can people use the crude oil and natural gas where they are? No.

What is the first thing people must do before they can use crude oil and natural gas? Take them out of the ground.

Ask the children if they know how crude oil and natural gas are taken out of the ground. Have them share briefly any information they have. Then have them examine the pictures and explanation on Student Book page 12. Ask individual children to read the captions for the pictures on Student Book page 12.

Picture 1. First scientists do tests to see if there might be oil under the ground.

Picture 2. To get the oil, oil workers bring out a machine called a *drilling rig*. The drilling rig has a tall tower called a *derrick*.

Put the words *drilling rig* and *derrick* on the board, making sure that the

children can read them. Also make sure that they realize that the whole thing is called the drilling rig, that only the tower part is called the derrick.

Picture 3. A long pipe fits down inside the derrick. At the end of the pipe is a *drill bit.* Powerful engines drive the drill bit down through earth and rock.

You may want to explain the concept of drilling by showing children a brace and bit or a simple electric drill. Put the words *drill bit* on the board.

Have the children use the drill and observe how the turning motion forces the drill bit down through hard material, like wood. If the rock is very hard, the drill bit will wear out before the job is finished. The workers must change it. This can happen many times during the drilling of an oil well. It is one reason why drilling for oil is so expensive.

Picture 4. If the drill bit strikes oil, some of the oil may rush up through the pipe by itself. If it does not, pumps like these raise the rest of it to the surface. Natural gas usually comes to the surface with the oil.

Now have the children answer the questions on page 12 in their notebooks or on the back of Activity Sheet 4 (distributed later in this activity).

The questions and possible answers are:

1. How do people know that there might be oil under the ground at a certain spot? From tests done by scientists.

2. What is the name of the machine that the oil workers bring to the spot? A drilling rig.

3. What is the name of the tall tower on a drilling rig? A derrick.

4. What do the workers put on the end of the long pipe that is inside a derrick? A drill bit.

5. What does a drill bit do? Drills down through the layers of earth and rock.

6. If there is oil in a well, how does it get up to the surface? Some of the oil rises by itself; the rest of the oil has to be pumped up.

When all the children have finished, have them share their answers in a class discussion.

Distribute Activity Sheet 4. It has been designed as a review of concepts learned to date (in Activities 1 to 4). The answers are: **1.** B, **2.** B, **3.** A, **4.** A, **5.** A, **6.** B, **7.** B, **8.** A, **9.** B.

EXTENSION

Have the children find out more about the machines used in finding and extracting crude oil and natural gas. Guide them in doing this research. You may wish to point out that the methods and machinery are somewhat different if a well is being drilled through the frozen ground in the far north, or offshore in the ocean floor.

Some children might draw labeled diagrams of various machines used in finding and extracting oil and natural gas. Other children might build models of these machines, using suitable parts from children's metal or plastic construction sets.

Copyright © SEEDS Foundation, 1981. All rights reserved.

Activity 7
Getting Fossil Fuels Ready for Use

OBJECTIVES

11. **Recognize that fossil fuels must be prepared and changed in various ways before people can use them.**
12. **Identify some uses and products of fossil fuels.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 25 min Extension: 10 min	Core: 45 min Extension: 45 min (flexible)	barbecue(s), electricity, gasoline, gas plant(s), heat(ing), pipeline(s), plastic(s), refinery, tanker(s), wax

Materials

Each child will need: Student Book, Activity Sheet 5, and a notebook / pencil.

You will need: Filmstrip and cassette, *Energy from Fossil Fuels*, (optional), and a projector / screen.

TEACHER BACKGROUND

Crude oil is a complex mixture of many compounds, which have two things in common: they can all be burned, and they are mainly molecules composed of hydrogen and carbon atoms called hydrocarbons. Crude oil from the well often contains water and natural gas. The water and gas are removed from the oil, which is then stored in tanks ready for shipment to the refinery. Once the oil is delivered to the refinery by ship, rail, or pipeline, it is again stored in tanks until it is refined.

At the refinery, crude oil is transformed into many different products. Gasoline constitutes about 40% of the production material. Other fuels and products include: kerosene and stove oil; domestic heating oil; bunker fuels for ships, power-generating stations, and large industrial plants; aviation fuels; gas fuels; lubricating oils; greases, waxes, and asphalts; and petrochemical feedstocks for plastics manufacturing.

The natural gas used in homes and industry is almost pure methane. The gas that comes out of the ground contains many other substances. These include: water; hydrogen sulfide; carbon dioxide; gases in liquid form — propane, butane, hexane, and pentane; mixtures of other crude liquid hydrocarbons; and even some crude oil.

At the gas-processing plant, these constituents are removed. Some are sent to petrochemical plants for further processing or to oil refineries to be made into petroleum products. Hydrogen sulfide provides elemental sulfur, most of which is stockpiled. Ethane, propane, and butane serve as raw materials for the petrochemical industries. Propane and butane are also used in residential, farm, and industrial heating.

Today, we are highly dependent on petrochemicals. Indeed, whatever we do and wherever we live it is almost impossible to avoid using products made wholly or partly from them. Much of our clothing is now made from such synthetic fibers as rayon, nylon, and polyester instead of wool or cotton. Carpeting, drapes, electrical plugs, cushions, chairs, flooring, and many other home furnishings are made of petrochemical products. Our food is packaged in plastic containers and plastic wrap. We drive in automobiles, airplanes, and boats made largely of plastic, and we use plastic toys, models, and games in our leisure time. Our dependence on petrochemicals increases with each day.

Coal and wood can also be used to produce petrochemicals. However, our main source today is petroleum, because it is the cheapest and most easily used. In the refining process, certain crude oil fractions or natural gas components are changed to products that can be used to form petrochemicals. Petroleum feedstocks may be supplied to the chemical industry by the oil companies. Alternatively, oil companies may manufacture the chemicals themselves or enter into joint operations with chemical companies.

Petrochemicals are distributed to various different industries that turn them into inks, synthetic lubricating oils, detergents, and such rubber prod-

ucts as shock absorbers and safety bumpers for cars. Nylon is sent to mills where it is made into tires, tubes, and other rubber products. Polyethylene pellets are molded by plastic processors into film or sheets for use in such products as plastic bags and garden hose. While petrochemicals are possibly most used in the plastics-processing industry, they are used widely in forestry, mining, textile manufacturing, construction, and agriculture as well.

CORE ACTIVITY

Filmstrip Energy from Fossil Fuels, *frames 25 to 32, may be used to* introduce *this activity.*

Have the children look at the pictures on Student Book page 13. Elicit from the children that the pictures show ways of getting fossil fuels to the places where they will be used. Have individual children read the caption that goes with each picture.

Picture 1. This train is taking coal to a power plant where it will be burned to make electricity.

Write the word *electricity* on the board and make sure children can read it.

Picture 2. Crude oil is often carried across the ocean to refineries in big ships called *tankers*. They are called tankers because they carry the oil in big tanks.

Ask:

Do you remember what the word *refine* means? It means to make clean.

Do you know what a *refinery* is? It is a place where crude oil is cleaned so that we can use it.

Write the words *tanker* and *refinery* on the board and make sure the children can read them.

Picture 3. Once the oil has been refined, it is taken across the country in large tank trucks like this one.

Tell the children:

Once crude oil has been refined, it can be made into many things. Can you name some uses for crude oil? Gasoline for cars and trucks; heating oil; airplane fuel; diesel fuel for big machines; wax for candles, waxed paper; medicines; paint thinners; roofing materials; fabric; perfumes; floor coverings (rugs and linoleum); plastic things.

Picture 4. Natural gas is taken from place to place by pipeline.

Ask the children to describe a pipeline to you. Make sure that they understand that a pipeline is a long line of pipes laid end to end and joined together securely. Pipelines usually run underground and can be used to carry natural gas, oil, and sometimes other substances great distances across the country.

Natural gas is often taken from the well to the refinery by pipeline. Once the gas has been cleaned in the refinery, it is taken, again by pipeline, to homes, offices, and factories where it is used.

Write the words *gas plant* and *pipeline* on the board and make sure the children can read them. Now ask:

Can you tell me how we use natural gas? To heat water in hot-water heaters, to cook food on gas stoves, to cook food on outdoor barbecues, to dry clothes in gas dryers, to keep food cold in gas refrigerators, to make heat in gas furnaces, to cool buildings. If the children are familiar with the use of propane gas, tell them that it is made from natural gas and is used for many of the same purposes. Now, have the children classify the uses for crude oil and natural gas in a chart in their notebooks or on the back of Activity Sheet 4.

Copyright © SEEDS Foundation, 1981. All rights reserved.

Have the children answer the questions on Student Book page 13 in their notebooks or on the back of Activity Sheet 4. The questions and possible answers are:

1. What must be done to crude oil and natural gas before we can use them? They must be cleaned, or refined.

2. How is natural gas taken from place to place? By pipeline.

3. How is coal taken from place to place? By train.

4. Where is it usually taken? To a power plant where it will be burned to make electricity.

5. How is crude oil carried across the ocean? In big ships called tankers.

When all the children have finished, have them share their answers in a class discussion.

Now, distribute Activity Sheet 5. Read the sentences with the children, if necessary, explaining any words they find difficult. The answers are:

1. pipeline, **2.** natural gas, **3.** gas plant, **4.** tanker, **5.** refinery, **6.** gasoline, **7.** heating oil, **8.** wax, **9.** plastic, **10.** coal.

EXTENSION

Have each child write this title at the top of a sheet of paper:

Fossil fuels were used to make these things.

Have the children take the lists home for two days. During that time they should list as many products made from fossil fuels as they can find. They may write the names of the products, draw simple sketches of them, or cut out pictures from newspapers and magazines.

On the other side of the paper, have each child write:

Were fossil fuels used to make these things?

If the children are unsure of the origin of a particular product, have them list it under this question.

At the end of two days, have the children help you to count the number of *different* products made from fossil fuels that they have listed. There will probably be many duplications. However, each item should be counted only once. For example, even though six children listed plastic bags, plastic bags would count as only one item.

Guide the children in doing research about the objects they were unsure about. They might obtain the information from a label on the object itself, from a catalogue or newspaper advertisement for the object, or from reference books such as encyclopedias and dictionaries.

Activity 8
Fossil Fuels and the Environment

OBJECTIVES

11. **Recognize that fossil fuels must be prepared and changed in various ways before people can use them.**
13. **Identify good and bad effects of extracting fossil fuels.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 60 min	Core: 60 min	environment, natural, prepare(ed)

Materials

Each child will need: Student Book, Activity Sheet 6, and a notebook / pencil.

You will need: simulated farm and accompanying natural environment made in a sand table or box of earth (Include such details as farmer's field, grass, trees, hills, wildlife, and a sample of coal or oil buried somewhere in the earth.); filmstrip and cassette, *Energy from Fossil Fuels* (optional); and a projector / screen.

TEACHER BACKGROUND

The production and use of energy has an impact on our environment. Mining coal, mining oil sand, drilling for oil and natural gas — they all affect nature's delicate balance. Although there are benefits from using each source of energy, there are also major concerns.

One such concern is the impact on our environment of extracting certain forms of energy, specifically the fossil fuels, which we rely on so heavily. Mining techniques can upset the natural balance in our environment, affecting not only plants and animals, but the elements these organisms rely on for life: water, air, and soil. Even though the sun — our primary source of energy — will continue to burn for a long time, if we don't look after all the other elements in the web of life, no amount of sunshine will be able to solve our problems.

In recent years, significant advances have been made in land-reclamation techniques in the areas of drainage, fertilization, land-use management, and planting programs. Mining companies are now usually required to replace the overburden and contour the land. After grass or a feed crop is established, tree varieties may be tested, and ponds may be developed to encourage the return of wildlife.

The children should be able to appreciate that each individual has a different point of view about an energy-extraction operation in his or her community. Business people, for example, will stand to gain through an increase of people in the community, accompanied by an increase in investment and purchasing opportunities. Other residents may appreciate the smallness and personal contact, the closeness to the environment, the unhurried atmosphere, and the reduction in stress that a small country community offers, and may therefore resist the proposed operation and its attendant changes.

CORE ACTIVITY

Filmstrip Energy from Fossil Fuels, *frames 19 to 24, can be used to* introduce *this activity.*

Ask the children to recall Activity 4 in which they learned how coal is taken out of the earth. Ask them:

In the strip mine, where did the miners find the coal? Close to the surface of the earth.

Where did they find the coal in the shaft mine? Deep under the surface of the earth.

Copyright © SEEDS Foundation, 1981. All rights reserved.

Why do we find coal under the surface of the earth? Where did it come from? Millions of years ago green, tree-like plants fell into swamps, were covered with mud and sand, and slowly turned into coal.

In strip mining, what do the machines do? Scrape away the topsoil, dig out the coal, and load it onto trucks.

Show the children the simulated farm and accompanying natural environment that you have made. Ask them to find the fossil fuel hidden under the earth. Do not tell them where it is.

Before the children begin to dig, have them make a chart on which they will record their observations, both before and after digging. Have individual children suggest headings for this chart. Have the children take turns — two or three at a time — digging for the fossil-fuel sample that you have concealed in the earth. When the fossil fuel has been found, have the children observe the effects of their digging and record it on their chart. Then ask:

How can strip mining hurt the environment? Sometimes it destroys grasslands, makes the area look ugly, frightens wildlife away...

If children are unfamiliar with the word *environment,* elicit a definition from them by asking:

What do you call all the things around a person, animal, plant, or thing? Surroundings or environment.

What do you think a wild duck's environment would be? Pond, reeds, grass, insects, frogs, earth, air, sky, sunshine.

Write the word *environment* on the board and make sure the children can read it. To check their understanding, have them describe the school's environment (It might consist of a city street, houses, apartment buildings, trees, lawns, robins, dogs, cats, earth, air, sky, and sunshine).

Would it be easy to make the environment exactly like it was before? No. **Why not?** Because it is impossible to put everything back exactly the way it was before.

Do you think that this is something like what happens when workers and machines come into an area to look for fossil fuels and take them out of the ground? Have the class discuss the question.

Have the children look at the pictures on Student Book page 14. Have individual children read the caption that goes with each picture.

Picture 1. This is what a strip mine looks like. Once the coal has been taken out, big machines smooth out the earth and put back the topsoil.

Picture 2. Once the land has been prepared, seeds are planted.

Picture 3. Trees can be planted, too.

Picture 4. This is how strip-mined land *can* look. Sometimes it is better for farms or parks than it was before.

Now discuss the extraction of crude oil and natural gas by means of questions such as:

How do people mine oil sand? By using methods and machines similar to those used in strip-mining for coal.

What two kinds of fossil fuels are found at an oil well? Crude oil and natural gas.

Why do we find crude oil and natural gas under the surface of the earth? Where did they come from? Tiny animals and plants died and fell to the ocean floor millions of years ago, were covered by mud and silt, and slowly changed into crude oil and natural gas.

How do oil workers get down to the crude oil and natural gas? They bring a drilling rig to the spot, put a long pipe into the derrick, put a drill bit on the end of the pipe, drill down through earth and rock until they reach the area of porous rock in which the crude oil and gas are trapped.

How do the oil workers bring the crude oil or natural gas up to the surface? At first it may come up by itself, through the pipe; later, the oil workers have to pump it up.

How can drilling for crude oil and natural gas sometimes hurt the environment? It sometimes destroys grasslands and / or valuable farmland, destroys the food supply of some wildlife, makes a lot of noise, dirties the air, damages roads, . . .

Do you think that drilling for oil and gas can cause as much damage to the environment as strip mining does? Not usually, because smaller areas are disturbed.

How do you think moving crude oil and natural gas from place to place can hurt the environment? Allow the children to speculate about the question. Make sure they understand that if crude oil or natural gas spills from pipelines, tankers, or tank trucks, the environment can be harmed. Plants cannot live in oil. Birds and fish die when oil covers their bodies. Natural gas can kill plants. It can kill animals too, if they breathe it. Oil companies must be very careful to keep oil spills from happening, and clean up spills when they do happen.

Now, have the children look at the pictures on Student Book page 15 and read the captions with them. Then have them answer the questions at the bottom of the page in their notebooks or on the back of Activity Sheet 5. The questions and possible answers are:

1. How do people try to fix up the environment again after the mining is finished? They smooth out the earth; replace the topsoil; they plant seeds and trees; they then can use the land for parks or farms.

2. Which can cause more damage to the environment — drilling for crude oil and natural gas, or moving them from place to place? Moving them from place to place.

Why? An oil spill can cause much more damage because plants, animals, and fish cannot live when their bodies are covered with oil. A break in a natural gas pipeline can kill plants in the area; animals can also be harmed if they breathe the gas.

When all the children have finished, have them share their answers in a class discussion. Then ask:

What are some of the good things that happen when workers drill for crude oil and natural gas? Jobs are created for people in the community and outside it; fossil fuels are supplied to people who need them; electricity can be made from the fossil fuels; sometimes the land is made better for farms or parks than it was before.

Distribute Activity Sheet 6. It has been designed as a review of concepts learned to date (in Activities 5 to 8). The answers are: **1.** A, **2.** A, **3.** B, **4.** B, **5.** B.

Copyright © SEEDS Foundation, 1981. All rights reserved.

Activity 9
Should We Extract Fossil Fuels?

OBJECTIVE **13. Identify good and bad effects of extracting fossil fuels.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 20 min	Core: 45 min	business, company, conservationist, damage, destroy, factory, restaurant, stockholder

Materials Each child will need: 1 role-playing card made from Activity Sheets 7 and 8, Activity Sheet 9, and a notebook / pencil.

CORE ACTIVITY

This activity consists of a role-playing game. The children will read out a part describing one effect that drilling for oil can have on a small, hypothetical community. When the game is finished, the children will fill in Activity Sheet 9 to summarize their feelings about the effect of the oil well on the community. If you have more than fifteen children in your class, some roles will need to be duplicated.

Explain the rules of the game to the class:

We are going to play a game. We are going to pretend that we live in a small town called Westbury. Oil has been discovered close to town. The oil company that has discovered the oil wants to set up several drilling rigs around the town. One will be on a nearby farm, one will be in the middle of a campground, and one will be in the wooded area to the south of town.

I will give each of you a card. You are to read, out loud, the sentences on the card, pretending to be that person. Then the class will decide whether or not the things you want will be good or bad for the whole community. Remember that you have to pretend to be the person on your card. I will call on you using the name of the person on your card.

Make sure that the children can read their parts. You might want to put some of the vocabulary on the board and make sure that the children can read and understand the words.

Call on various children making sure that the good and bad effects are well mixed. Keep a running tally on the board. If some children want to go on defending their positions, allow them to, within limits.

When the role-playing and accompanying discussion is finished, distribute Activity Sheet 9. Help the children to read the sentences, if necessary. Write *destroy* and *damage* on the board and make sure the children can read and understand them. Explain any other words that seem difficult. Then have them write the word *bad* or *good* after each sentence to indicate whether the effect is a negative or a positive one. Answers are: **1.** bad, **2.** good, **3.** bad, **4.** bad, **5.** good, **6.** bad, **7.** bad, **8.** good, **9.** bad, **10.** good / bad.

Activity 10
Fossil Fuels are Nonrenewable

OBJECTIVES

5. **Recognize that fossil fuels provide most of the energy used in our community today.**
14. **Distinguish between renewable energy sources (such as wind, water, and wood) and nonrenewable energy sources (such as coal, oil, and natural gas).**
15. **Recognize that the earth's supply of fossil fuels is limited.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 35 min Extension: 15 min	Core: 60 min Extension: 25 min (ongoing for several days)	limited, nonrenewable, renewable

Materials

Each child will need: Student Book; Activity Sheets 10, 11, and 12; and a notebook / pencil.

You will need: birthday candles in three different colors, preferably blue, yellow, and red; three separate objects in which to mount the candles — could be pots of soil or muffins (If using muffins, bring some extras so there will be a small sample for each child.); matches; large seeds such as corn, bean, or radish seeds; stopwatch, if available; filmstrip and cassette, *Energy from Fossil Fuels* (optional); and a projector / screen.

TEACHER BACKGROUND

Energy sources can be classified as either renewable or nonrenewable. Nonrenewable sources are those that are exhaustible. In other words, when we use what we have, we have no more. The fossil fuels — oil, coal, and natural gas — are all in this category. Uranium is also a nonrenewable source of nuclear energy.

Renewable sources are those that are replenished even as they are used. Sources of renewable energy include the wind, running water, and biomass (energy from once living things). Energy that comes directly from the sun, solar energy, is also referred to as renewable energy. Because the amount of fuel (hydrogen) in the sun is so immense, in the course of our lives and for as long as we can imagine, the sun will not burn out.

CORE ACTIVITY

Filmstrip Energy from Fossil Fuels, *frames 1 to 10, may be used to* introduce this activity.

Have the children turn to Student Book page 16. Show the children the birthday candles that you have brought to school. Ask:

What are birthday candles made of? Wax.

Where do people get wax? It is a product of crude oil; it is made from crude oil at a factory.

Have the children look at the colors of the candles. Tell them that you are *not* going to light the blue candle at all. However, you are going to light the yellow one. You will light it and let it burn only as long as it takes the class to sing "Happy Birthday." Then the child to whom they are singing will blow it out.

Copyright © SEEDS Foundation, 1981 All rights reserved

Ask if anyone is having a birthday. If so, the class can sing to that person. If not, choose a child who will pretend to be having a birthday and who will blow out the yellow candle after the class has finished singing.

Before you begin, tell the class that you are also going to light the red candle. However, you are not going to have anyone blow it out. You are simply going to let it burn.

Ask the children:

Which candle do you think will last the longest? The blue one.

Why? Because it is not going to be lit; because it is not going to be used.

How long do you think the red candle will last after I light it? Have several children make predictions and write them on the board. Have children make a chart on which they will record their observations. The chart could be in a form like this:

	Length before	Length after	Time burned
Blue			
Red			
Yellow			

Have a volunteer measure each candle before and after the demonstration.

Appoint a capable child to time the burning of the red candle by the classroom clock or by a stopwatch. Place the red candle far enough away from the yellow one so that it will not be blown out accidentally.

Then carry out the demonstration. Light the yellow and red candles, one after the other. As soon as you have done so, lead the class in singing "Happy Birthday." When they have finished singing, have the "birthday child" blow out the yellow candle. Have the children watch as the red candle burns away. When the red candle has burned itself out, have the child whom you appointed tell the class how many minutes the red candle lasted.

Now, have the children answer the questions on Student Book page 16 in their notebooks or on the back of Activity Sheet 9. The questions and possible answers are:

1. How much of the blue candle is left? All of it.

Why? Because we didn't light it, because we didn't use up any of its energy.

2. How much of the yellow candle is left? Quite a bit, more than half, . . .

Why? Because we used it for only a short time, because we used up only part of its energy.

3. What kinds of energy do we get from the candles? Light and heat energy.

4. How much of the red candle is left? Very little, only a small stub, only a bit of blackened wick.

Why? Because we used it for a long time, because we used up all of its energy.

Now, show the children the remains of the red candle. Ask them:

What would happen if I put this in a pot of soil? Could I grow a new red candle? No, nothing would happen.

When all the children have finished, have them share their answers and observations in a class discussion.

Then show the children the seeds that you have brought. Ask:

What would happen if I put these in a pot of soil? Could I grow new plants from them? Yes.

Write the headings *Nonrenewable* and *Renewable* on the board. Under the heading *Nonrenewable*, write *wax candles*. Under the heading *Renewable*, write *plants*.

If you brought your candles to school in muffins, divide the muffins among the children at this time. As they eat, ask:

What plants were used to make the ingredients for the muffins? Wheat plants to make flour, wheat plants to make bran, oat plants to make oatmeal, sugar beets or sugar cane to make sugar, grapevines to make raisins, . . .

Ask the children:

What happens if you plant seeds from these plants? They grow and produce new plants of the same kind.

Elicit from the children that plants are a renewable source of energy. Ask them if they can name any other renewable sources of energy. If necessary, remind them that wood, wind, water, and the sun are all called renewable sources of energy. Have a child list these on the board under the heading *Renewable.*

Then ask:

Are the fossil fuels renewable?

Discuss this question, briefly reviewing how fossil fuels were formed millions of years ago. The processes by which fossil fuels were formed are still going on. However, this happens very slowly and only in places where conditions are just right. Fossil fuels being formed now will not be ready in time to be of any use to us. The only ones that we will be able to use are those that were formed millions of years ago. Thus the usable supply of usable fossil fuels is limited. When we say something is limited, we mean there is only a certain amount of it. When it is gone, there won't be any more. When people have used up all the coal, oil, and natural gas on earth, these fossil fuels will be gone forever. We will no longer have them to use as sources of energy.

Have a child list coal, crude oil, and natural gas under the heading *Nonrenewable* on the board. Ask the children:

Now that we know the supply of fossil fuels is limited, what should we do about it?

Write the question on the board. Do not propose any answers yourself at this time, but encourage the children to think about the question and make suggestions.

If possible, leave the question on the board. Tell the children it is a question that is very important to government leaders and many other people at this time. There are no easy answers. However, if we all take the problem seriously and work together, we may be able to find some solutions.

Distribute Activity Sheets 10, 11, and 12. Tell the children that, in examining the question about fossil fuels, it will be helpful to have more information about how we and our families actually use fossil fuels. Have the children look at Activity Sheet 11. Read with them the column headings *many times a day, once a day, twice a week*, and so on.

Copyright © SEEDS Foundation, 1981. All rights reserved.

EXTENSION

You may wish to do the following as a further demonstration of the limited nature of some forms of energy. Obtain two flashlights and two inexpensive, identical batteries. Show them to the children. Explain that the batteries produce electricity. They do this in a special way. (The electricity is not made in a power plant and carried by wires like most of the electricity that we use.)

Turn the flashlights on without putting the batteries in. Have the children observe that nothing happens. Turn the flashlights off. Then put the batteries in and turn the flashlights on again. Ask:

Are the flashlights using energy from the batteries? Yes.

How do we know? We can see the light.

Do you think the energy in the batteries is limited? Can it be used up?

Allow the children to express their opinions briefly. Then tell them that you are going to do an experiment to see how long the electrical energy from the batteries will last.

Put a piece of tape or other marker on one of the flashlights. Turn it on and tell the children that you are going to leave it on all the time from now until the battery burns out. Ask them how long they think the battery's energy will last. Allow several children to make predictions.

Appoint a "flashlight committee" of three or four children. The committee's responsibility will be to turn the other flashlight on when all the children enter the room, see that it stays on while they are in the room, and turn it off when they leave. The committee will also chart this information on the board.

Ask the children:

Which flashlight do you think will work longer? Probably the one that is on only while we are in the classroom.

Continue the experiment over the next few days, at least until the flashlight that is on all the time burns out. Conclude by comparing the energy producing power of the flashlight batteries with fossil fuels: Both are limited; if we keep on using them, they will eventually be used up; and if we use them less often, they will last longer.

Activity 11
How Can We use Fossil Fuels Wisely?

OBJECTIVES

4. **Recognize the basic concept of conservation (saving through wise use).**
5. **Recognize that fossil fuels provide most of the energy used in our community today.**
14. **Distinguish between renewable energy sources (such as wind, water and wood) and nonrenewable energy sources (such as coal, oil, and natural gas).**
15. **Recognize that the earth's supply of fossil fuels is limited.**
16. **Give examples of how we can use fossil fuels wisely.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 20 min	Core: 40 min	air conditioner, mixer, muscle, potato, stove, toaster

Materials

Each child will need: Student Book and Activity Sheets 11 and 12 (completed with the help of his / her family and brought back to school).

You will need: Filmstrip and cassette, *Energy from Fossil Fuels* (optional), and a projector / screen.

TEACHER BACKGROUND

Every year we use more and more of our nonrenewable energy supplies. Today everyone is worried that these supplies will soon run out. Not very long ago this was not a major concern. Until the middle of the nineteenth century, animals were the main source of energy available to do work. Since they were a renewable source of energy, there was no need to worry about using up the energy available. Once new technology enabled us to utilize the cheaper and more efficient energy supplied by fossil fuels, however, the "energy drain" began.

Our technology naturally shifts to the energy source that is most easily available and most economical. In the past, this has meant a movement from animal energy to wood, to coal, and most recently to oil and natural gas. In North America, oil supplies almost half of the total energy needs, as the following estimates indicate: petroleum supplies 45%, natural gas supplies 22%, coal supplies 14%, hydroelectric power supplies 15%, nuclear energy supplies 4%.

Because of advances in technology and an abundance of cheap fuel, our consumption of oil has multiplied rapidly. Recent surveys indicate that our use of oil is doubling every ten years. For example, in 1965, each automobile contained about 75 kg of plastic parts; in 1979, this had increased to 440 kg. In 1968 about 103 kg of plastic was used by each North American; ten years later this use had increased to 224 kg.

Although no one is certain how much oil remains to be extracted, most experts agree that our supplies will eventually be exhausted. If we continue doubling our consumption every ten years, we may not have adequate time to develop other energy sources to replace oil.

Exploration for new oil deposits is becoming increasingly expensive as well. As long as there are abundant sources, the return on the money invested in exploration for new oil deposits is high. As supplies are exhausted, however, more money must be spent to discover whatever is left. The most accessible deposits of oil in North America have already been developed, and we are now forced to develop new, expensive technology to recover oil from such sources as the Alberta oil-sand deposit.

It is becoming more and more apparent that we need to eliminate our waste of oil-based products and obtain more from each unit of oil used. We can use our dwindling supplies of energy wisely by concentrating on conservation.

Even young children can learn to use fossil-fuel

Copyright © SEEDS Foundation, 1981. All rights reserved.

energy wisely: to use it only when they really need it, and to substitute other kinds of energy whenever possible, especially personal energy — energy from food. If we fail to conserve energy now, we risk facing a future in which there is insufficient energy to maintain the lifestyle we desire.

CORE ACTIVITY

Filmstrip Energy from Fossil Fuels, *frames 34 to 40, may be used to* introduce *this activity.*

Have the children look at their copies of Activity Sheets 11 and 12, which they should now have completed with the help of their parents. Ask a few general questions such as:

Which machines and appliances does your family use many times a day? Why?

Which machines and appliances does your family never use at all? Why?

Remind the children of the question that you wrote on the board during the last activity.

Now that we know the supply of fossil fuels is limited, what should we do about it?

Ask if the children have had any further ideas about the question. Accept any reasonable thoughts on the subject. Someone will probably advance the idea that we should use fossil fuels wisely. When this idea is mentioned, pursue it further by asking:

How can we use energy from fossil fuels wisely?

Remind the children that electricity is often made by burning fossil fuels. Now have the children look at Student Book page 17.

How can we use the toaster wisely? Toast two slices when you can.

How can we use the electric mixer wisely? Mash potatoes with a potato masher.

How can we use the stove wisely? Cook (and eat) one-pot meals like stews.

How can we use the air conditioner wisely? Use an electric fan.

How can we use the TV wisely? Play a game instead.

How can we use the electric toothbrush wisely? Use a muscle-powered one instead.

Continue, asking about other items listed on Activity Sheets 11 and 12. Choose those that are the most interesting and that are familiar to the children. Accept any reasonable ideas for using the machines and appliances wisely. If someone suggests saving energy by not using the machine or appliance at all, agree that this might be a good idea. Tell the children that you will explore this idea further in the future.

Explain that, now, in preparation for Activity 14, you would like to make an exact count of how often all of the families used each appliance or machine. Ask the children to hand their activity sheets in to you. Tell them that you will bring the results of the count to class in time for Activity 14. If any children have forgotten to bring their activity sheets back to school, have them do so as soon as possible so that their information may be included in the count.

You may wish to appoint a "Counting Committee" to help you compile the summary. For best results, the summary should be made on an overhead transparency or on a large chart that all the children can see easily. For each item, record how many families use it many times a day, how many use it once a day, and so on.

Activity 12
The Story of Sneakers

OBJECTIVES

5. **Recognize that fossil fuels provide most of the energy used in our community today.**
11. **Recognize that fossil fuels must be prepared and changed in various ways before people can use them.**
12. **Identify some uses and products of fossil fuels.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 10 min Extension: 10 min	Core: 30 min Extension: 30 min	conveyor belt, fabric(s), foam, glue(ed), sew(n)

Materials Each child will need: Student Book and a notebook / pencil.

CORE ACTIVITY

The purpose of this activity is to have the children discover, by tracing the many steps in the manufacturing process, how fossil fuels are involved in the production of the familiar things around us. Have the children turn to Student Book pages 18 and 19. Read the title with them:

The Story of Sneakers.

Ask the children:

What do you think your sneakers are made of? Nylon fabric, plastic foam, . . .

What are all those things made from? Fossil fuels.

Have the children look at the flow charts on pages 18 and 19. They show the step-by-step way in which people make a pair of sneakers.

Why do you think the sun is the first thing in this story about sneakers? Because sneakers are made from fossil fuels and fossil fuels are "buried sunshine."

Can you tell me about the second picture? Plants and tiny animals that died millions of years ago are slowly turning into fossil fuels.

What does the third step show? A drilling rig.

What is the drilling rig doing? It is taking oil and natural gas out of the ground.

Now, what is happening to the oil and natural gas? It is being taken to a refinery by pipeline.

What happens to the crude oil and natural gas at the refinery? It is cleaned and made ready for us to use in many different ways.

What does the last step on page 18 show us? It shows a large train with tank cars taking refined fossil fuels to a factory where the fossil fuels will be made into different kinds of plastics.

Put the words *fabrics* and *foam* on the board and make sure the children can read and understand them. Ask:

What do you think gives the train the energy to move? Diesel fuel.

Copyright © SEEDS Foundation, 1981. All rights reserved.

What is diesel fuel made of? Refined crude oil.

Elicit from the children that the train is using energy from crude oil to carry other products made from crude oil to the factory.

The next flow chart shows how fossil fuels continue to be used in the production of a pair of sneakers. Ask:

What does the first step on page 19 show? A large truck bringing different kinds of plastics from the factory where they were made to the sneaker factory.

What gives the truck energy to move? Gasoline (or diesel fuel).

What is gasoline made from? Crude oil.

What are the plastics that the truck is carrying made from? Crude oil.

The next step shows the sneakers being made. Ask the children what they think runs the cutting machines, the conveyor belts, the sewing machines, and the gluing machines. You should be able to elicit that they all run on electricity.

Put the words *glued, sewn,* and *conveyor belt* on the board, and make sure the children can read them. Ask:

Where does the energy to make electricity come from? It can come from moving water or from burning fossil fuels. In North America, most of the energy used to make electricity comes from fossil fuels.

What does the next step show? A large truck taking the finished sneakers from the factory to a store.

Where does the energy to run the truck come from? From gasoline or diesel fuel.

What does the last step show? A shoe store where the sneakers will be sold.

What heats and lights the store? Energy from fossil fuels.

Now, have the children answer the questions on Student Book page 19 in their notebooks or on the back of Activity Sheet 12. The questions and suggested answers are:

1. What is the one thing that is used in every step in the making of sneakers? Energy from fossil fuels.

2. List some other things that we use and wear that are made in the same way. Discuss this question for as long as you like, making sure that the children realize that fossil fuels are an essential part of our lives.

For the next activity, you will need: a collection of things made from fossil fuels — disposable plastic cutlery, plates, cups; plastic containers; packaging from various sources — try to include something that is conspicuously over-packaged; and magazines and newspapers — one for every two children.

EXTENSION

Have the children pretend that the supply of fossil fuels is so limited that each person can have only one object that is made from or that uses fossil fuels. Have each child decide which object he / she would choose (electric train, stove, lamps, . . .) Briefly discuss the reasons for the decisions.

Then, have each child draw a picture of his / her object and write a brief explanation of why it was chosen. As necessary, assist the children in writing their explanations. You may wish to have them use the following form:

I would choose_____

because_____

_____ .

Activity 13
When in Doubt, Leave It Out!

OBJECTIVES

4. **Recognize the basic concept of conservation (saving through wise use).**
15. **Recognize that the earth's supply of fossil fuels is limited.**
16. **Give examples of how we can use fossil fuels wisely.**
17. **Distinguish between needs and wants.**
18. **Identify ways in which we can save fossil fuels by using only those machines, appliances, and products that we really need.**
19. **Recognize that the use of fossil fuels and their products can affect the environment in serious ways.**

Preparation Time
Core: 15 min

Instruction Time
Core: 35 min

Reading Vocabulary
garbage, package(ing), product(s), reduce, reuse

Materials

Each child will need: Student Book, Activity Sheet 13, and a notebook / pencil.

You will need: a collection of things made from fossil fuels — disposable plastic cutlery, plates, cups; plastic containers; packaging from various sources — try to include something that is conspicuously over-packaged; and magazines and newspapers — one for every two children.

TEACHER BACKGROUND

Packaging is the largest component of waste in today's society. Many people today spend more money on gift wrappings than their parents did on presents. As a result of mass production, it is often cheaper to make new items than to reuse or recycle the old ones. Eventually, however, the throwaway containers will cost more than the reusable type and the problems of litter pick-up make it obvious that it is time to evaluate packaging techniques.

There are three basic ways of reducing waste.

Reuse Save all items that may be repaired and reused or used in another way (e.g. jars for kitchen containers). Buy beverages in returnable containers.

Recycle Separate jars, tins, and newspapers and take them to recycling depots.

Reduce Buy only what you need and only in the package that produces the least amount of wasted resources (e.g. paper, cardboard, foil, plastic). Buy some products in bulk to reduce packaging of separate items. Buy as few disposable items as possible. Avoid buying items because of their appealing packages.

CORE ACTIVITY

If possible, arrange a display of things that are made from fossil fuels (paints, synthetic fabrics, floor coverings, plastic toys, plastic dishes, . . .).

In Activity 11, the children learned about ways of saving energy from fossil fuels. Ask if the children can think of another way of saving fossil fuels (besides saving the energy that they produce).

Discuss the question, leading the children to discover that we can save fossil fuels through wise use of the *products* of fossil fuels. Remind them how fossil

Copyright © SEEDS Foundation, 1981. All rights reserved

fuels (or products made from fossil fuels) were used in almost every step in the process of making a pair of sneakers. Indicating your collection of items made from fossil fuels, ask the children:

As you look at all these things, can you tell me how we can save fossil fuels?

Help the children to answer this question by telling them there are many ways we all can help to save fossil fuels. One of the ways is to *reuse* things made from fossil fuels. Write the word *reuse* on the board.

Ask the children:

How can we reuse things made from fossil fuels? We can wear hand-me-down clothing made from fossil fuels; we can reuse plastic bags for storage, plastic containers for storage or toys; when clothing or bedding is too worn to be of further use, it can be reused as rags, or made into rugs or stuffing for toys.

Tell children that another way to save energy from fossil fuels is to *reduce* our use of things made from fossil fuels. Write the word *reduce* on the board. Ask the children to suggest some ways.

One answer might be to avoid using disposable things made from fossil fuels. These include things like throwaway plastic knives, forks, and spoons, plates, cups, and glasses.

Have children examine your conspicuously over-packaged item. Have individual children pull off one layer of packaging each. As they stand in front of the class holding their bit of packaging, ask:

Does this show another way of reducing our use of fossil fuels? Yes. We should try to buy products that are packaged simply. The important thing is what is inside the package.

Write the word *packaging* on the board. Elicit from the children that some packaging is necessary. Most food items are packaged to preserve them, protect them from breakage, and keep them clean. But often, layers upon layers of plastic wrap, plastic bubbles, or plastic-coated cardboard serve no purpose. Have the children look at Student Book page 20. Tell them that they will be able to answer the question at the end of the activity.

Now ask:

What will happen to all this packaging when I start to use this product? It will be thrown into the garbage can.

What happens to disposable plastic things like plates, once they've been used? They are thrown into the garbage.

Have children turn to Student Book page 21. Tell them:

This is a picture of a garbage dump (If you prefer, and your class will understand, you can use the term *sanitary landfill site.*).

What do you think garbage dumps do to the environment?

Write the word *garbage* on the board. Have the children discuss the environmental effects of garbage. You may want to point out that these effects are minimized when the dump is filled, because the garbage is covered over and the land replanted with grass. But we are running out of places to put our garbage — we need to reduce the amount we throw out, both to save fossil fuels and to reduce the damage to the environment.

Divide your class into groups of two. Have each group look through magazines and newspapers for about ten minutes. During that time, have the groups tear out all the pages with things they see advertised. Discuss the various advertised objects, asking questions such as:

Does this thing use energy from fossil fuels? Is the whole thing, or part of it, made from fossil fuels?

Does it have a lot of packaging, especially packaging made from fossil fuels?

Is it made to be used once or only a few times, and then thrown away?

What kinds of problems do you think it might cause after it is thrown away? How could it affect the environment?

Your discussion can be brief or detailed, depending on the time available and the children's knowledge and interest. To conclude the discussion, have the children classify the objects, stating which ones they *could* buy as wise users of fossil fuels and which ones they would be better to avoid.

Now, have the children answer the questions on page 21 in their notebooks or on the back of Activity Sheet 13 (to be used later in the activity). The questions and possible answers are:

1. Which of the products on page 20 would you buy? Why? Cheese in one piece because it is wrapped only once, the loose apples because they can be put in one bag, the unwrapped toy because bubble wrap wastes fossil fuels, the big box of cereal because it is wrapped only once.

2. What kinds of things should we try not to use? Throwaway things, things with too much packaging.

3. Why should we try to reduce our use of things made from fossil fuels? Because fossil fuels are nonrenewable. We should try to save fossil fuels.

4. Why should we try to reuse things made from fossil fuels? Because by throwing them out we waste fossil fuels and make more garbage.

When all the children have finished, have them share their answers in a class discussion.

Distribute Activity Sheet 13. It has been designed as a review of concepts learned to date (in Activities 9 to 13). The answers are: **1.** A, **2.** A, **3.** B, **4.** A, **5.** C.

Copyright © SEEDS Foundation, 1981 All rights reserved

Activity 14
Use Other Kinds of Energy If You Can

OBJECTIVES

4. **Recognize the basic concept of conservation (saving through wise use).**
15. **Recognize that the earth's supply of fossil fuels is limited.**
16. **Give examples of how we can use fossil fuels wisely.**
17. **Distinguish between needs and wants.**
18. **Identify ways in which we can save fossil fuels by using only those machines, appliances, and products that we really need.**
19. **Recognize that the use of fossil fuels and their products can affect the environment in serious ways.**
20. **Identify ways of using alternative sources of energy, especially energy from food.**

Preparation Time	**Instruction Time**	**Reading Vocabulary**
Core: 25 min Enrichment: 15 min	Core: 45 min (flexible) Enrichment: 45 min (flexible)	energy saver, energy user, supply

Materials

Each child will need: Student Book, Activity Sheet 14, Activity Sheet 15 (for Enrichment), and a notebook / pencil or crayons.

CORE ACTIVITY

Remind the children of the question they have been considering:

Now that we know the supply of fossil fuels is limited, what should we do about it?

Write the question on the board. Ask the children what they have discovered about the answer. Accept any reasonable answers, making sure that the following points are made:

1. Appliances and machines that depend on energy from fossil fuels should be used wisely.

2. We should avoid wasting and throwing away things made from fossil fuels — in order to save fossil fuels as well as to protect our environment.

Now display the overhead transparency or chart on which you have summarized the information from Activity Sheets 11 and 12. If you wish, return the children's individual activity sheets to them at this time.

Have the children discuss the summary, noting which items were used frequently by many families and which were seldom used by many families.

Then ask:

Suppose we had to do without some of the things on the list. Which things could we most easily do without?

Discuss the question, allowing the children to present their own ideas. Lead

them to the realization that we could most easily do without the machines and appliances that we seldom use. For example, if most families seldom use an electric knife, they could probably do without this item entirely. However, if most families use a toaster once a day, they would probably find it difficult to do without this item.

Have the students pretend that your community's supply of energy from fossil fuels has suddenly been cut to half of what the community usually uses. Say:

Suppose we had only half as much fossil-fuel energy to use. Which things on the list would we probably stop using altogether? Which things would we have to keep on using?

Go through the list with the children, having them state for each item whether we would stop using it altogether or would need to keep on using it. Ask a child to draw a heavy line through items that the majority of children feel we would stop using if energy supplies were limited. Ask the children to turn to Student Book page 22 and look at the pictures.

Picture 1. Reading by electric lamp Reading by sunlight

Picture 2. Sitting by a warm air register Sitting by a woodstove

Picture 3. Drying clothes in a clothesdryer Drying clothes on a clothesline

Now ask:

What do these pictures show? Two ways of doing the same thing.

What kind of energy is being used in the first set of pictures? Electrical energy; energy from the sun.

In the second set? Energy from oil or natural gas; energy from wood.

In the third set? Electrical energy; energy from wind.

Now ask:

Can you think of any other kind of energy we can use instead of energy from fossil fuels? We can save energy from fossil fuels by using our own personal energy — food energy.

Elicit from the children that this may even make us healthier. For example, the exercise we gain by walking to school tones our muscles, develops our hearts and lungs, may keep us from getting fat, . . . Also, if we walk rather than asking somebody to drive us, the air we breathe will stay a little cleaner because it doesn't get the exhaust fumes from the car.

Have the children look at Student Book page 23. Have a volunteer read the question:

Now that we know that the supply of energy from fossil fuels is limited, what can we do about it?

Have individual children observe what is happening in the pictures and tell the class. Then have different volunteers read the summarizing sentences:

We don't really need some of the things that get their energy from fossil fuels. If we don't need them, we should stop using them.

We should try not to waste or throw away things that are made from fossil fuels. This will help to protect our environment, too.

We should use other kinds of energy whenever we can, especially food energy.

Have the children discuss what they are doing and what they can do in the future to save energy from fossil fuels.

Distribute Activity Sheet 14. Tell the children that the words on the left-hand side of the page describe things and activities that use energy from fossil

Copyright © SEEDS Foundation, 1981. All rights reserved.

fuels. The things and activities described on the right-hand side of the page save energy from fossil fuels. They are to match each energy user with the corresponding energy saver by writing the appropriate number on the line. Read the items with the children, helping them with any unfamiliar words. Then have them complete Activity Sheet 14. The answers are: 6, 7, 10, 9, 2, 3, 1, 12, 11, 5, 4, 8.

EXTENSION

Remind the children that most of the energy we use in our community still comes from fossil fuels. However, in the future, we may start using more energy from other sources. Discuss possible new uses for energy from the sun, wind, water,...

If anybody in your community is experimenting with new ways of using alternative energy sources, try to arrange for the students to investigate these new ways. For example, someone may be designing a new kind of solar home, making a new kind of fuel from animal wastes, or using a new kind of windmill to generate electricity.

You may wish to challenge the children to think of their own new ways of using alternative energy sources. The children could be placed in groups for this activity. At the end of a specified time, a representative from the group might make an oral report on the group's ideas. Or the group could work together to make a small-scale model or chart depicting its ideas.

ENRICHMENT

Art and Language Arts Distribute Activity Sheet 15. Have the children pretend that the home drawn there is their own. They are to choose furnishings, appliances, and machines for the home. Discuss their choices with them, reminding them to be wise users of energy.

After some discussion, have each child draw into the various rooms the furnishings, appliances, and machines that he / she has decided on. If desired, the children may color their completed houses.

Then have each child choose one or more rooms of the house and write a brief paragraph explaining how he / she uses energy wisely in that room, for example:

Bathroom

I use my own energy to brush my teeth. I never leave the tap running because I don't want to waste hot water. I always remember to turn off the bathroom light.

The children may write their paragraphs either on the back of Activity Sheet 15 or in their notebooks.

Activity 15
What Have You Learned about Fossil Fuels?

OBJECTIVE **21. Recall and review the concepts presented in this module.**

Preparation Time
Core: 25 min

Instruction Time
Core: 60 min (flexible)

Materials

Each child will need: Student Book and a notebook / pencil.

You will need: Filmstrip and cassette, *Energy from Fossil Fuels*, and a projector / screen.

CORE ACTIVITY

Show the filmstrip, *Energy from Fossil Fuels*, as a means of reviewing what the children have learned about fossil fuels. You may wish to show the pictures without the sound and have the children explain what is happening in each frame, then show the filmstrip right through as a review. The following questions can be used to guide the discussion:

Frames 1 – 4 **Where do people and animals get their energy?** They get their energy from eating food.

Frame 5 **Where do plants get energy?** Plants make their own food from sunlight, soil, water, and air.

Frames 6 – 10 **Water, wind, and wood are sources of energy. What kind of sources are they?** They are renewable sources of energy.
Do we use renewable sources of energy a lot? No, we don't.

Frames 11 – 18 **What other kinds of energy do we use?** We use energy from electricity and energy from fossil fuels — coal, oil, and natural gas.

Frames 19 – 21 **How were fossil fuels formed?** They were formed from the bodies of plants and tiny animals that died millions of years ago.
Why do we call fossil fuels "buried sunshine"? Because the plants and tiny animals used energy from the sun to live and grow millions of years ago.

Frames 22 – 24 **How are coal, oil, and natural gas taken out of the earth?** By drilling for oil and natural gas; by digging for coal.

Frames 25 – 29 **How are coal, oil, and natural gas brought to where they can be used?** By pipeline, by tank truck, by ocean-going tanker, by train.

Frames 31 – 32 **What is one very important use of fossil fuels?** They can be burned to generate electricity.

Frame 33 **Why should we use fossil fuels wisely?** Because they are nonrenewable. Once they are used up, they're all gone.

Frames 34 – 39 **How can we use fossil fuels wisely?** By using less; by using our own muscle power (food energy) instead of fossil-fuel energy; by reusing things made from fossil fuels.

The composite picture on Student Book page 24 is intended to review the whole subject of fossil fuels. Have the children refresh their memories by

Copyright © SEEDS Foundation, 1981 All rights reserved

looking at the picture. Then have them answer the questions on page 24 in their notebooks or on the back of Activity Sheet 14. The questions and suggested answers are:

1. What are fossil fuels made from? The bodies of plants and tiny animals.

2. Why are fossil fuels called "buried sunshine?" Because the plants and tiny animals that they came from used the sun's energy to live and grow.

3. How do we get fossil fuels? We dig for coal and oil sand; we drill for oil and natural gas.

4. Once fossil fuels are out of the ground, what happens to them? They are refined so that we can burn them; they are made into products that we can use.

5. Why must we use fossil-fuel energy and products wisely? Because fossil fuels are nonrenewable; once we have used up what there is in the ground, we won't have any more for a long, long time. Extracting and using fossil fuels can harm our environment.

SCRIPTS FOR SOUND FILMSTRIPS

Concept Framework: Energy Everywhere

1 Every day we get energy from the sun . . . in towns . . .

2 and on farms.

3 Our bodies use energy to work . . .

4 . . . and to play.

5 We need energy to live and to grow.

6 Animals need energy to live and to grow, too.

7 Both people and animals get their energy from food.

8 We eat plants. Many animals eat plants, too.

9 We eat many different kinds of plants. Where do plants get energy to live and to grow?

10 Plants make their own food. They use air, water, soil, and the energy of the sun to make their own food.

11 Without the sun, plants would not get rain water. How does the sun make rain water?

12 The sun's heat makes tiny bits of water rise from lakes and oceans into the air. These tiny bits of water come together to form clouds. Later, the water falls from the clouds as rain or snow.

13 Plants need energy from the sun to live and to grow.

14 All living things need the sun's energy.

15 Many animals eat plants.

16 People eat plants and animals.

17 So, the sun is the most important thing in the making of our food. The sun gives plants energy to grow. Many animals eat plants. People eat plants and animals.

18 All living things need the sun's energy to give them their food.

19 But most people do not grow their own food.

20 Farmers have to work hard to grow food for people.

21 Farmers grow plants and raise animals so that we will have food to eat.

22 Farmers use machines. Machines are not alive, but they do move. When they move, they are using energy.

23 In our cities, we have many machines that do work for us.

24 Some machines get energy from gasoline.

25 Some machines get energy from electricity.

26 Most of the machines that heat our homes get energy from oil or natural gas.

27 Every day we use a lot of energy from electricity, oil, and natural gas. We should use this energy wisely.

28 We can travel on buses instead of using our cars. This will save gasoline.

29 We can ride our bicycles to places that are close to us. This will save gasoline, too.

30 We should turn off TV sets and lights when we're not using them. By doing this, we'll save electricity.

31 And, on cold days, if we wear sweaters and turn down the heat, we'll save oil or natural gas.

32 We use energy from electricity, oil, and natural gas every day in cities.

33 We use energy from oil, natural gas, and electricity every day in the country, too.

34 And every day, people, animals, and plants get energy from the sun.

35 Every day, everywhere on our earth, living things get their energy from the sun.

SEEDS 3: Energy from Fossil Fuels

1 Every day we get heat and light from the sun.

2 And every day we use body energy to play and to work.

3 Animals use body energy every day, too. Where do people and animals get their energy?

4 People and animals get their energy from food. Some of this food energy comes from plants.

5 Plants make their own food from soil, air, water, and sunlight. Plants live and grow, and renew themselves. We need food energy from plants to live and to grow.

Copyright © SEEDS Foundation, 1981. All rights reserved

6 Moving water is another source of energy. People have used water energy to do many things—to grind grain, for example.

7 People have also used wind energy to do things. For example, wind energy can move sailboats. Wind and water energy are both made by the sun.

8 The sun makes wood energy, too. Trees need the sun's energy to grow.

9 Wood energy gives us light, and heat for warmth and cooking.

10 Wood, wind, and water are renewable sources of energy. But we don't use them very much. What sources of energy do we use?

11 Electricity is one source of energy we use. It does many things for us.

12 Electricity gives us light, and heat for cooking.

13 Electricity powers machines that do work for us.

14 And some homes are heated by electricity.

15 Many homes are heated by furnaces that burn oil or natural gas. A few homes have coal furnaces.

16 Buses and cars take us where we want to go. They use gasoline, which comes from oil.

17 Oil, coal, and natural gas are fossil fuels. Fossil fuels are important sources of energy for our homes and machines.

18 Without fossil fuels we would live in a darker, colder world—a world without fuel for cars and buses. Where do fossil fuels come from?

19 Fossil fuels were formed underground millions of years ago.

20 Fossil fuels are "buried sunshine." Their energy comes from the sun's energy that was stored in plants and tiny animals that lived millions of years ago.

21 These plants and tiny animals died and were covered with mud. They were pressed together over millions of years. Slowly they changed into coal, oil, and natural gas.

22 Today, we drill underground to get oil and natural gas. To get coal, we sometimes have to dig deep underground mines.

23 In other places, coal is found near the surface of the earth. There it is collected by strip mining. Strip mining gives us coal, but it harms the natural environment.

24 Oil drilling causes less damage to the environment than strip mining does.

25 Coal, oil, and natural gas must be taken from where they are found to places where people will use them.

26 Pipelines carry oil and natural gas great distances.

27 Pipes take natural gas directly to furnaces which heat homes and buildings.

28 Oil trucks deliver oil to our homes.

29 And gasoline, which is made from oil, is delivered to gas stations by tanker trucks.

30 Coal is carried, by coal train or coal ship, to places where people use it.

31 Coal, oil, and natural gas are sometimes used to make electricity.

32 Electric wires bring electricity to our homes. Electricity gives us heat and light. Some electricity is made from fossil fuels.

33 But fossil fuels are nonrenewable. Once fossil fuels are used up, they can't be replaced. We must use them wisely.

34 We should turn off lights and TV sets when we're not using them.

35 On cold days, we should wear sweaters and use lower heat settings, to feel comfortable.

36 For short trips, we could ride bicycles or walk to save gasoline. When we use energy, we should consider our real needs, not just our wants.

37 Do we really need an electric toothbrush? We can clean our teeth just as well with an ordinary toothbrush.

38 Do we really need an electric can opener? We can use our own go-power and save energy.

39 There are many ways we can save nonrenewable energy.

40 Many of the things we need and the things we enjoy use energy from fossil fuels.

41 Fossil fuels are important sources of energy for us. We depend upon them every day, so we should use them wisely.

SEEDS 3

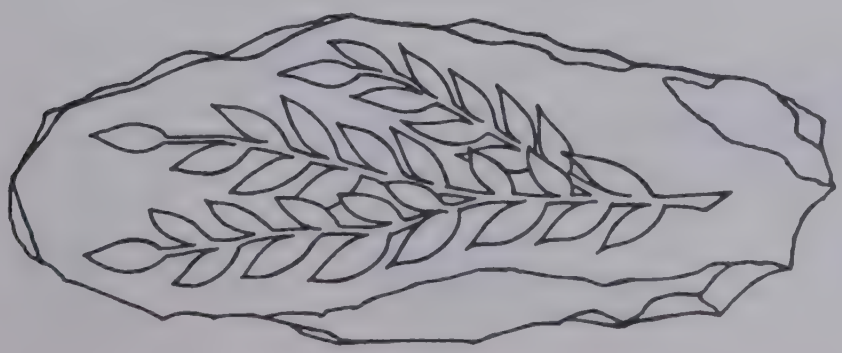
Activity Sheet 1

For use with Activity 3

Can you tell the story of coal?
Use these words to fill in the blanks:

sand sun rock coal plants years water

1. Millions of years ago green _____ grew.
2. They used energy from the _____ to live and grow.
3. When they died, they fell into the _____ .
4. Many other dead plants fell in, too. Mud and _____ covered them.
5. Many _____ passed, and many changes took place on earth.
6. The mud and sand above the plants were packed more and more tightly together. At last they changed into _____ .
7. All the dead plants were packed more and more tightly too. At last, they changed into _____ .



Copyright © SEEDS Foundation, 1981. All rights reserved Permission to reproduce for classroom use

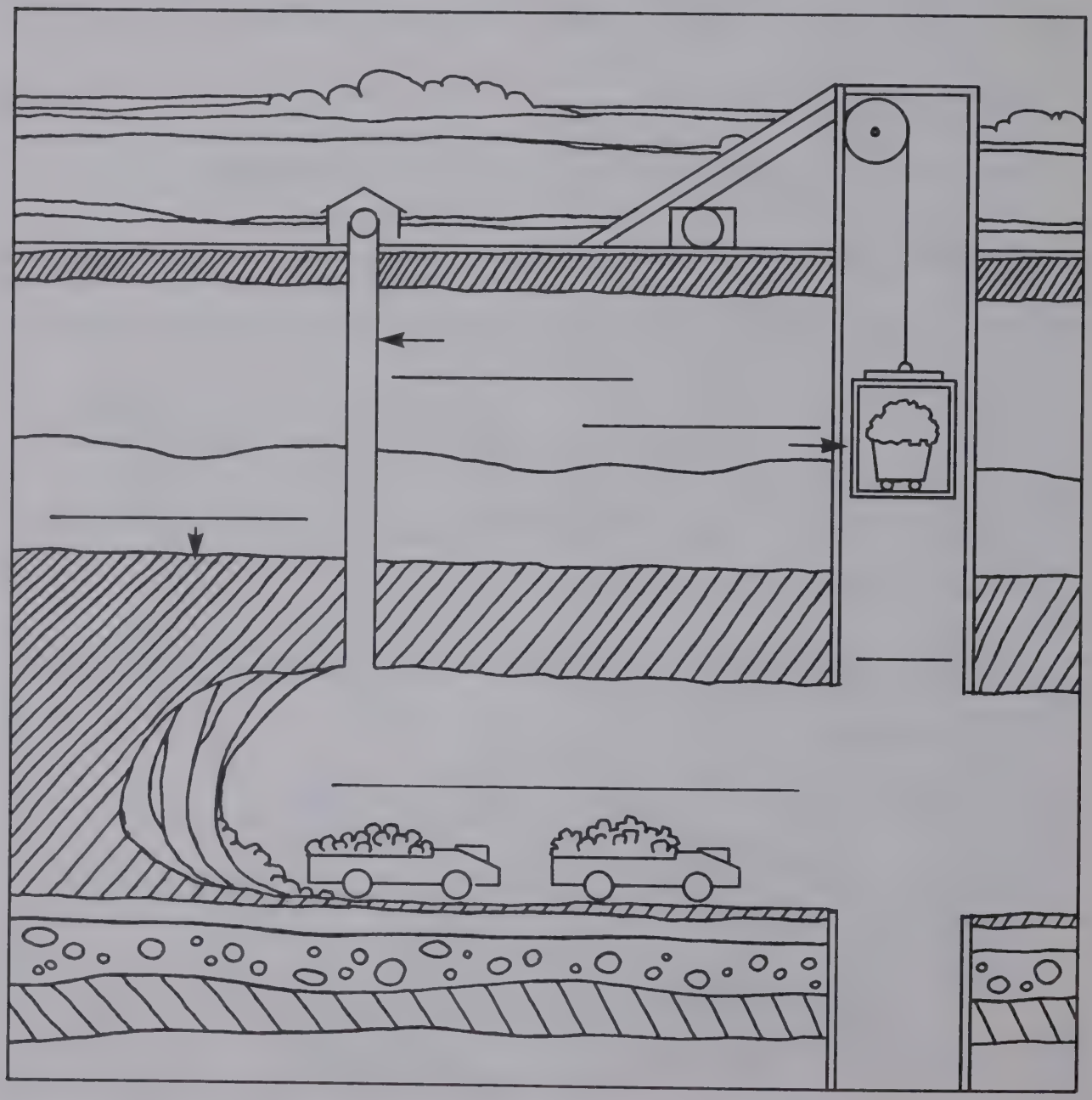
SEEDS 3

Activity Sheet 2

For use with Activity 4

Label the parts of a shaft mine. Use these words:

elevator shuttle cars shaft coal seam air shaft



Copyright © SEEDS Foundation, 1981. All rights reserved. Permission to reproduce for classroom use.

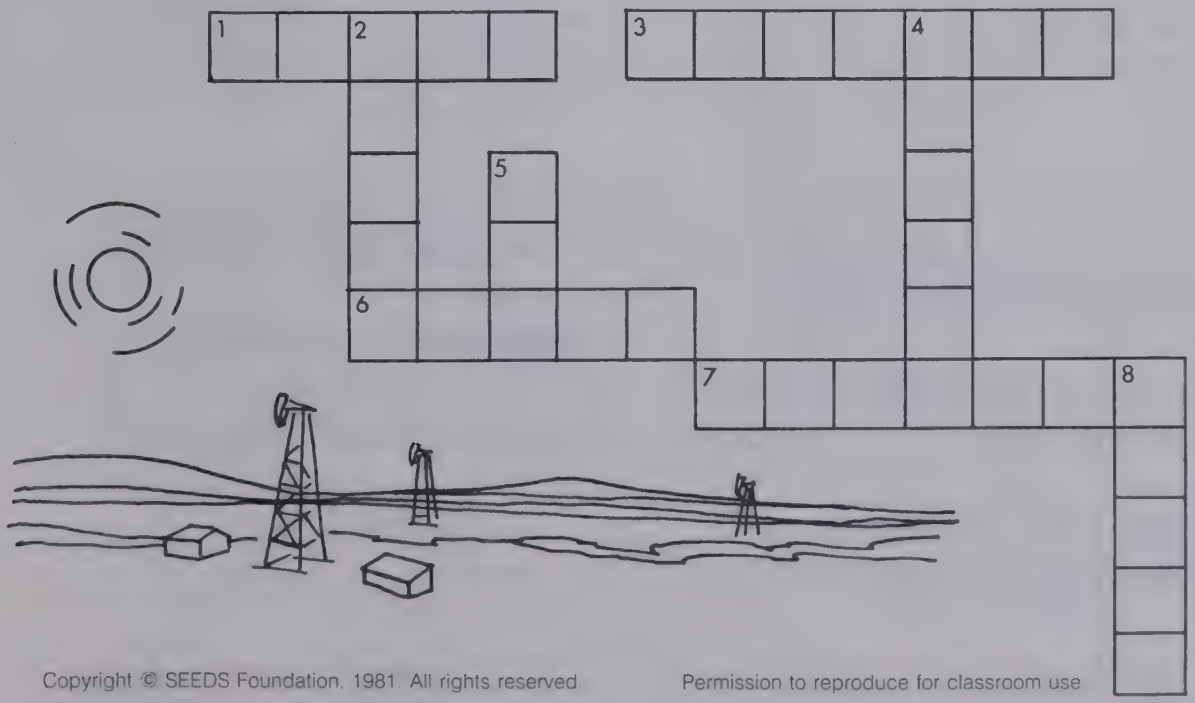
SEEDS 3 Activity Sheet 3

For use with Activity 5

Use the words to fill in the blanks and solve the crossword puzzle about crude oil and natural gas.

rock trapped holes earth ocean covered drill oil

1. Millions of years ago many tiny sea animals and plants sank to the bottom of the _____ .
2. Mud and fine sand _____ them.
3. As the _____ shifted and changed, the layers were pressed more and more tightly together.
4. At last the mud and fine sand turned to _____ .
5. The bodies of the sea animals and plants slowly turned into crude _____ and natural gas.
6. The crude oil and natural gas often seeped into rocks that had many tiny _____ in them.
7. But whenever the crude oil and natural gas reached solid rock, they stopped. They were _____ !
8. Today people who _____ for oil often find crude oil, natural gas, and water together under a folded layer of solid rock.



Copyright © SEEDS Foundation, 1981. All rights reserved. Permission to reproduce for classroom use

SEEDS 3

Activity Sheet 4

For use with Activity 6

What have you learned about fossil fuels?

Read each sentence.
Circle A or B to show which group of words ends the sentence correctly.

1. The fossil fuels we use today were formed
   A. about twenty years ago.
   B. millions of years ago.

2. Coal was formed from
   A. black rocks.
   B. tree-like green plants.

3. Crude oil and natural gas were formed from
   A. the bodies of tiny animals and plants.
   B. salty water mixed with bits of iron.

4. Crude oil and natural gas often travel long distances under the ground by soaking into rocks that
   A. have many tiny holes in them.
   B. are very shiny.

5. Crude oil and natural gas are sometimes trapped under the ground when they reach a layer of
   A. solid rock.
   B. tree roots.

6. Miners dig holes called *shafts* to reach coal that is
   A. in liquid form.
   B. deep under the ground.

7. In an underground oil trap, natural gas rises to the top because it is
   A. heavier than water.
   B. lighter than oil.

8. Oil workers use a drill bit to
   A. reach an underground oil trap.
   B. bring oil to the surface.

9. The tall tower on a drilling rig is called a
   A. shuttle car.
   B. derrick.

Copyright © SEEDS Foundation, 1981. All rights reserved. Permission to reproduce for classroom use.

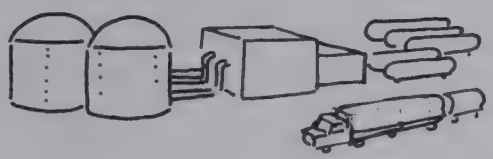
SEEDS 3 Activity Sheet 5

For use with Activity 7

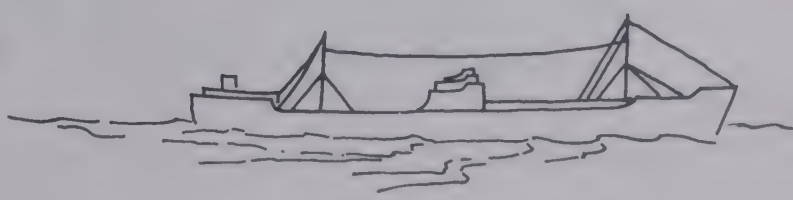
Fill in the missing letters:

gas plant refinery heating oil pipeline plastic coal
gasoline tanker wax natural gas

1. This takes natural gas from the well to the refinery.
   p __ p __ l __ __ __
2. People often use this to cook food in outdoor barbecues.
   n __ t __ r __ __ g __ __



3. This place gets natural gas ready for people to use.
   g __ __ p __ __ __ __
4. People use this to take crude oil across the ocean.
   t __ __ k __ __
5. This place cleans crude oil and gets it ready for people to use. r __ f __ n __ __y
6. People make this from crude oil, and use it to make their cars and trucks run.
   g __ s __ l __ __ __
7. People make this from crude oil, and burn it in furnaces to keep their homes warm.
   h __ __ t __ __ g o __ __
8. People make this from crude oil, and use it to make candles.
   w __ __
9. People make this from crude oil, and use it to make telephones and toothbrushes and toys and many other things.
   p l __ s __ __ __
10. Workers dig this out of a mine and send it off to be burned as a fuel.
    c __ __ l



Copyright © SEEDS Foundation, 1981 All rights reserved

Permission to reproduce for classroom use

SEEDS 3

Activity Sheet 6

For use with Activity 8

What have you learned about fossil fuels?
Read each sentence.
Circle A or B to show which group of words ends the sentence correctly.

1. People usually send natural gas from one place to another by
   A. underground pipeline.
   B. airplane.

2. People sometimes send oil from one place to another in big ships called
   A. tankers.
   B. trailers.

3. A gas plant and a refinery are alike because they both
   A. make electricity for people to use.
   B. get fossil fuels ready for people to use.

4. After strip mining, land can be
   A. made exactly the same as it was before.
   B. made to grow grass or crops again.

5. If oil spills on the land from a big oil truck,
   A. plants grow better than they did before.
   B. plants will die if the oil is not cleaned up.

Copyright © SEEDS Foundation, 1981. All rights reserved.

Permission to reproduce for classroom use.

SEEDS 3

Activity Sheet 7

For use with Activity 9

Storekeeper The oil well is good for my business. Many more people have come to work here, and they buy food from my store.	**School-Bus Driver** I don't like the way the big machines tear up the country roads. They are very bumpy and muddy now. It's hard to drive on them.
Lucy (a nine-year-old student) I like to watch the big machines at work. It's fun!	**Cub Scout** The big machines from the oil company are right in the middle of our old campsite. We won't be able to use it any more.
Oil Company Worker Drilling the oil well is my job. It helps me earn money to feed my family.	**Oil Company Owner** I need this oil well so that I can sell oil and natural gas to people to use in their cars, to heat their houses, and to cook their food.
Farmer The big machines are in the middle of my best field. I can't grow grain in it now for my cattle.	**Doctor** This town is a very good, healthful place to live but the big machines can make the air dirty, and that can make people sick.

Copyright © SEEDS Foundation, 1981. All rights reserved. Permission to reproduce for classroom use

Activity Sheet 8

For use with Activity 9

Factory Owner
I'm glad they have found more oil. My factory needs oil. We can make many different things from crude oil for everyone to use.

Brownie
I'm afraid that the big machines will drive away the deer and the rabbits and the gophers that my Brownie pack goes out to watch in the woods.

School Teacher
The noise from the drilling rig bothers my students. They would rather watch the big machines than do their work.

Restaurant Owner
The oil well is good for my business. Many more people come into my restaurant to eat. I need the natural gas to cook food for them.

Bob (a nine-year-old student)
I think the oil well is a good idea. I like all the things I use that are made from plastic.

Conservationist
I think that the oil company should leave the oil in the ground. We use too much of it now, and we will run out unless we are careful.

Oil Company Stockholder
I'm glad they are drilling more oil wells. My oil company stock is worth more so I'm making money.

Copyright © SEEDS Foundation, 1981. All rights reserved.

Permission to reproduce for classroom use.

SEEDS 3 Activity Sheet 9

For use with Activity 9

When people take fossil fuels out of the ground, some bad things happen and some good things happen.
Write *bad* or *good* after each sentence.

1. Sometimes woods and grasslands are destroyed. _____
2. There are many new jobs for people. _____
3. Big machines sometimes damage roads. _____
4. Mining and drilling machines make a lot of noise. _____
5. People have fossil fuels to use for heating their homes, cooking their food, and running their cars. _____
6. Mining and drilling machines dirty the air. _____
7. Farmers' fields are destroyed. _____
8. Sometimes the land can be made better for farming than it was before. _____
9. Wild animals' homes and food are destroyed. _____
10. Oil companies make more money. _____

Copyright © SEEDS Foundation, 1981 All rights reserved

Permission to reproduce for classroom use

Activity Sheet 10

For use with Activity 11, but distributed in Activity 10

_____

(date)

Dear Parent:

Your child has been learning about the use of fossil-fuel energy (energy from coal, oil, and natural gas). Electricity has been included in this study since much of the electrical energy we use is made by burning fossil fuels.

We are using more energy than ever before. There are more of us now than in the past, and we all have more machines and appliances.

We would appreciate your help in illustrating the many ways in which fossil fuels are used. Could you assist your child in completing the checklist on the next page? Please show how often your family uses each machine or appliance by checking (✓) the column that fits best.

Thank you in advance for your assistance.
Yours truly,

_____

(signature)

Copyright © SEEDS Foundation, 1981. All rights reserved. Permission to reproduce for classroom use.

SEEDS 3

Activity Sheet 11

For use with Activity 11, but distributed in Activity 10

Please show how often your family uses each machine or appliance by checking (✓) the column that fits best.

	Many times a day	Once a day	Twice a week	Once a month	Once a year	Not at all
1. toaster						
dishwasher						
electric mixer						
trash compactor						
electric can opener						
natural gas stove						
microwave oven						
electric knife						
blender						
electric frying pan						
waffle iron						
electric coffee pot						
2. electric fan						
air conditioner						
oil furnace						
natural gas furnace						
electric furnace or heater						
gas jet in fireplace						
heat lamp						
sauna						
hot tub						

Copyright © SEEDS Foundation, 1981. All rights reserved. Permission to reproduce for classroom use.

SEEDS 3

Activity Sheet 12

For use with Activity 11, but distributed in Activity 10

	Many times a day	Once a day	Twice a week	Once a week	Once a month	Once a year	Not at all
3. electric barbecue starter							
gas barbecue							
gas lawn mower							
electric lawn mower							
snow blower							
electric hedge clippers							
4. electric garage door opener							
automobile							
truck							
motorcycle							
motorboat							
motorhome							
in-car warmer for auto							
block heater for auto							
5. vacuum cleaner							
electric lights and lamps							
electric washing machine							
electric clothes dryer							
gas clothes dryer							
electric iron							
6. electric toothbrush							
electric razor							
hair dryer							
electric curling iron							
7. record player							
radio							
TV set							
tape recorder							

Copyright © SEEDS Foundation, 1981. All rights reserved.

Permission to reproduce for classroom use.

SEEDS 3 Activity Sheet 13

For use with Activity 13

What have you learned about fossil fuels?
Read each sentence.
Circle A, B, or C to show which group of words ends the sentence correctly.

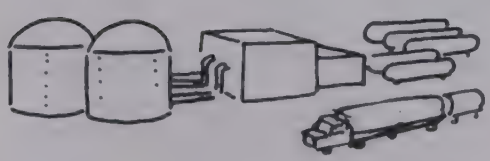
1. One way of making electricity is by
   A. burning a fossil fuel in a power plant.
   B. letting the sun shine on black sheets of plastic.

2. Some kinds of energy that can be renewed are:
   A. wood, wind, water.
   B. gasoline, heating oil, natural gas.

3. If we keep on wasting fossil fuels
   A. our environment will become cleaner and cleaner.
   B. someday there may not be any fossil fuels left for us to use.

4. One important way of saving fossil fuels is to
   A. use their energy only when we really need it.
   B. buy plastic things that can be used once and then thrown away.

5. When we buy things that are over-packaged, we are:
   A. wasting fossil fuels.
   B. creating more garbage.
   C. doing both of the above.



Copyright © SEEDS Foundation, 1981. All rights reserved

Permission to reproduce for classroom use

SEEDS 3 Activity Sheet 14

For use with Activity 14

The actions on the left use energy from fossil fuels.
The actions on the right save energy from fossil fuels.
Match the *energy users* with the *energy savers* by writing the numbers on the lines at the right.

1. using a lamp for reading
2. riding to the store in a car
3. using a gasoline lawn mower
4. cutting meat with an electric knife
5. throwing a plastic lunch bag away
6. using a gas clothes dryer
7. washing a car at a car wash
8. using a lamp for growing plants
9. playing a record
10. cooling a room with an air conditioner
11. using a gas barbecue
12. watching TV

____ hanging clothes on a line
____ washing a car with a pail of water and a cloth
____ opening a window
____ playing the piano or a guitar
____ walking to the store
____ using a push lawn mower
____ using sunlight for reading
____ reading a book or playing a game
____ making a wood fire to cook food outdoors
____ taking a plastic lunch bag home to use again (or using a lunch box every day)
____ cutting meat with an ordinary knife
____ using sunlight for growing plants

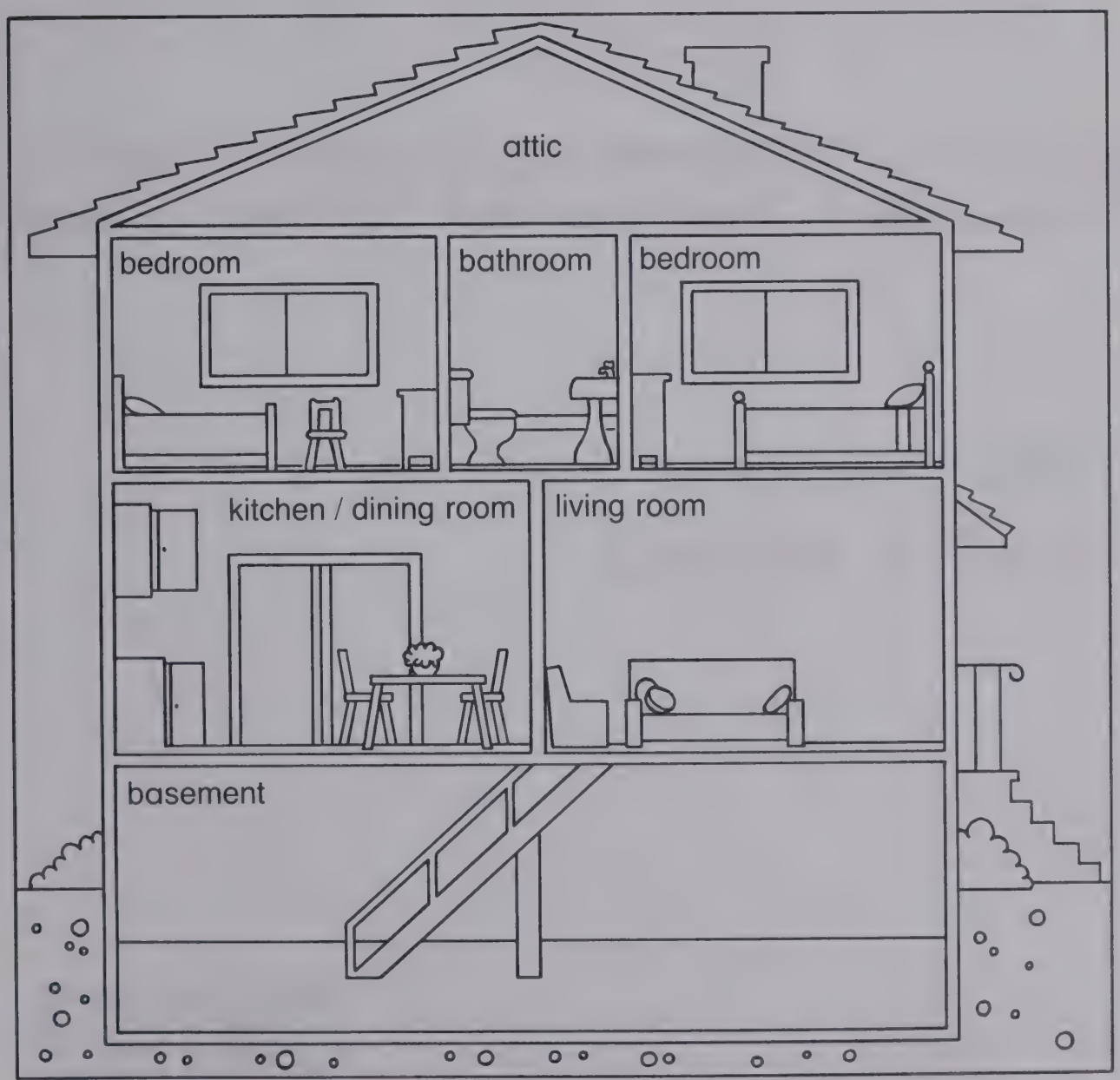
Copyright © SEEDS Foundation, 1981. All rights reserved. Permission to reproduce for classroom use.

SEEDS 3

Activity Sheet 15

For use with Activity 14

Pretend that this is your house.
You want to save energy from fossil fuels.
Draw the things that you would put in your house.



Copyright © SEEDS Foundation, 1981 All rights reserved.

Permission to reproduce for classroom use.

SEEDS

The Energy Literacy Series

Professional Reference Guide

Levels 1 to 6

SRA

SCIENCE RESEARCH ASSOCIATES (CANADA) LIMITED

Toronto, Montreal, Chicago, Palo Alto, Sydney, Henley-on-Thames

SEEDS Foundation

EXECUTIVE DIRECTOR: Robert Westbury

PROGRAM DIRECTOR: Hugh Phillips

SRA

EDITORIAL TEAM: **Judith Reeves-Stevens**, Karin Velcheff, Joe Sobura, Sherry Henderson

WRITER-CONSULTANT: Elma Schemenauer

PRODUCTION COORDINATOR: Shelagh Roberts

DESIGN: Henning Christensen Graphics

ACKNOWLEDGMENTS:

Every effort has been made to identify and credit appropriately the sources of all copyright material used in this book. Any information concerning perceived errors or omissions will be appreciated, and the correct source acknowledged in subsequent editions.

Page 5 *Energy Education: Goals and Practices.* "Justification of Energy Education" by Rodney F. Allen. © 1980, Phi Delta Kappa Educational Foundation. Reprinted with permission from Phi Delta Kappa Educational Foundation and Rodney F. Allen.

Copyright © Society, Environment & Energy Development Studies Foundation, 1981.
Published by Science Research Associates (Canada) Limited.
All rights reserved. Printed in Canada.

No part of this publication may be reproduced or transmitted in any form, including any storage or retrieval system, or by any means, electronic, mechanical, photographic, or recording, without permission in writing from the publisher.

Printing History

9 8 7 6 5 4 3 2 1 81 82 83 84 85 86 87 88 89 90

Reorder No. 3-280400 ISBN 0-574-09400-8

CONTENTS

Introduction 5

Definitions and Concepts 7

Content Summaries 9
- Level 1 9
- Level 2 9
- Level 3 10
- Level 4 10
- Level 5 11
- Level 6 11
- Additional Investigations 11

Core Objectives and Skills 13
- Method of Listing Objectives in SEEDS 1—6 13
- Energy Literacy Objectives Chart 14
- The Cognitive Objectives 24
- Learning, Thinking, and Valuing Skills Chart 25
- Process Skills Chart 34
- The Attitudinal Objectives 35

Integrating SEEDS with the Elementary Curriculum 36
- Relationship of SEEDS to Science, Social Studies, and other Subject Areas 36
- Practical Suggestions on Scheduling and Timetables 37

Teaching Strategies Used To Present and Develop Concepts 38
- The "Guided Discovery" Approach 38
- Questioning and Class Discussion 39
- Story Approach in SEEDS Levels 1—3 39
- Group Activities 40
- Community-based Activities 40

Review and Evaluation 42

Materials 43
- Materials Found within the Program Itself 43
- Concrete Materials To Accompany the Program 43
- Printed Materials as a Resource for the SEEDS Program 44
- Audio-visual Materials for SEEDS 1—6 45
- Choosing Supplementary Audio-visual Materials 48
- Using Audio-visual Materials 48

Introduction

The SEEDS materials have been designed for use either as an energy unit in a core science or social studies curriculum or to stand on their own as an energy curriculum. The Teacher's Guides for each level of the SEEDS program present strategies and techniques for the *how* of teaching the program's energy literacy concepts and skills. This Professional Reference Guide provides a comprehensive view of the *what* and the *why*. The cross-level content development, the spiral pattern of expanding concepts, the learning / thinking / valuing skills, and the progression and interrelationship of objectives and skills from level to level are summarized in subsequent sections and in the charts on pages 25–33 and pages 14–23. However, it is important at this point to restate the original motivation and rationale for the program.

Robert Westbury, Executive Director of the SEEDS Foundation, summarized the history of the Foundation and the development of the Curriculum Project in a brief Preface at the beginning of each Teacher's Guide. Two statements bear repeating here: The primary goal of the Foundation—"to encourage the development of an energy-literate society, a society concerned about and committed to the wise use of energy"; and the rationale for the educational modules that comprise the Curriculum Project—"to help young people develop informed views on energy and the environment and act on them."

In the process of preparing the material for publication, Dr. Westbury was intrigued to find that another concerned educator, Rodney F. Allen, had independently compiled the following list of "justifications" for energy education in the booklet, *Energy Education: Goals and Practices*, published by the Phi Delta Kappa Educational Foundation in 1980:

"*Educated Citizenry Justification:* A basic premise of democracy is that citizens with adequate skills and knowledge participate in making the decisions that affect them. Solutions to energy problems require a knowledge of, and participation in, the political process. Traditionally, education has served to equip citizens with the knowledge and skills needed to make such decisions and to take action.

"*Economic Justification:* Energy education is needed so that citizens may make rational choices in their personal lives about public policy questions.

" '*Doing Good*' *Justification:* Energy education offers the opportunity to create a more just and humane society. It can provide the re-educative process that will lead to a more environmentally sound lifestyle and a more equitable distribution of goods and services in the national and world community.

"*Problem-Solving Justification:* Solving widespread energy and environmental problems can be undertaken by a well-educated citizenry. Since energy is so directly related to the conditions that sustain life and give it meaning, educational programs are needed to provide the techniques for solving the energy crisis.

" '*Take Care of Self*' *Justification:* Energy education can teach people how to conserve energy and to make decisions to optimize their personal resources and well-being. Such learning will build personal responsibility and will help to protect personal effects.

"*Educated Person Justification:* Society is beset with technological problems about resource use that require educated and inquiring minds. Energy education should be part of general education now and in the twenty-first century. A sound knowledge of energy concepts and issues should be expected of all educated people.

"*Career Education Justification:* Many of today's students will find careers in energy industries (e.g., solar installation, energy audits, and energy-efficient construction) or in industries that depend on crucial energy decisions. Schools have a role in preparing students for these and other careers.

"*Stewardship Justification:* Energy education, like environmental education, offers an opportunity for persons to learn a "common good" ethic where the well-being of all people (including those yet unborn) is taken seriously in resource use and in the allocation of goods and services. If everything is connected to everything else, we need to learn those relationships and to use them. The

welfare of all and responsibility to the posterity of our nation are central themes in this argument.

"*Apocalyptic Justification:* We must learn the wise use of energy resources since there is such a limited supply of nonrenewable energy resources. National survival and the well-being of the world community depend upon effective and equitable use of energy to ward off resource depletion on the one hand and environmental disaster on the other. We need people who can stand at Armageddon and do battle for our survival.

"Whether or not one concurs with all of the justifications offered here for energy education programs in the schools, learning about energy is essential for the social education of all children whose lives will extend well into the twenty-first century. In responding to dwindling energy supplies, our technological advances may be spectacular. Legislation may force us into immediate conservation efforts. Pricing mechanisms may cause life-style changes. But in the long run, it is the knowledge, abilities, and personal commitments of the people in a free society that will permit successful responses to the energy crisis."

The Foundation does not claim such all-encompassing justifications for either its own existence or the curriculum materials, but interwoven in its name are the three topics that recur in the descriptions above—Society, Environment, and Energy. The main ideas grouped into these three strands evolved from the preliminary content analysis undertaken by the educators for the preparation of the curriculum materials.

The main ideas provide the broad organizing concepts, drawn from the social sciences, the natural sciences, and the physical sciences, that recur from level to level throughout the program. They are presented within different contexts and with gradually increasing complexity as the students progress. The process of concept-learning is inherent in the specific objectives, stated in terms of learning outcomes expected for the students.

We have used the term "energy literacy" to describe this process designed to lead to the development of informed views on energy and the environment. But the objectives also reflect the behavioral goals of changing one's attitude, of taking action on a personal level and in related social issues, of conserving energy where possible, of wisely *using* rather than *abusing* our natural resources.

Definitions and Concepts

In developing the main concepts from the social, the natural, and the physical sciences, the presentation in the student materials has been written to the level of the average student's understanding. This has, at times, necessitated the simplification of explanations or definitions. For example, the statement "energy is the ability to do work," while satisfying to scientists, is only puzzling for most young students. Children can more easily gain an appreciation of the meaning through activities and experiences that broaden their understanding.

For more capable students, more detailed definitions or explanations should not be avoided. But all children should be encouraged to continue testing, exploring, investigating, and discussing observations until they can give a satisfactory explanation in their own words. At that point, the name for a concept or the accepted definition can be provided by the teacher.

For this reason, we have provided some background information for teachers who may not have a full command of the concepts dealt with in the program. These Teacher Background sections are provided to reduce the need for teacher preparation. However, there is no substitute for in-depth teacher preparation and practical investigation since both teachers and students benefit from the processes of investigating, hypothesizing, and testing in order to gain a better understanding of how our world functions. Teachers should be aware that the following topics in particular have been presented in a simplified form consistently in all components of the elementary levels: the definition of energy, the definition of solar energy, the description of energy flow on earth, and the definitions of "renewable" and "nonrenewable" as applied to sources of energy. For teachers who feel that their students can benefit from a more technical explanation of these topics, the following essay should prove helpful.

Energy is a quality or state of an object or set of physical circumstances. Energy can be thought of as the source of all activity in the physical world. Physical phenomena represent transformations or exchanges of energy. Thus, the classical definition of energy as "the ability to do work" reflects the difficulty we have in defining it as a concrete, physical entity. We tend to quantify and describe energy in terms of what it can *do* rather than what it *is*.

On earth, our main source of energy is the sun which is a middle-aged star, about four and one-half-billion years old, that has not yet exhausted its hydrogen fuel. Spectral analysis of the sun's light and other astronomical data indicate that about three-quarters of the sun's mass is hydrogen; about 20% or more is helium; and the remainder is composed of traces of elements like carbon, nitrogen, oxygen, magnesium, and silicon.

Using information gained partly by observation and partly by theoretical models, scientists have described the sun as composed of various layers: the *core* where thermonuclear reactions occur; the *convection zone;* the *photosphere* or deepest visible layer; the *reversing layer;* and the *atmosphere*, composed of the *chromosphere* and the *corona.* The atmospheric layers may have temperatures of over 1 000 000°C but the photosphere is only about 6 000°C. From the photosphere inwards, the temperatures, pressures, and density of material increase dramatically. The temperature of the core is about 20 000 000°C. At the temperatures and pressures encountered near the center of the sun, only the most elemental forms of matter can exist—atomic nuclei must be nearly stripped of their electrons. *Plasma* is the term used to describe this "fourth state of matter" which is not solid, liquid, or gas.

The sun is like a gigantic hydrogen bomb generating energy in its core at a prodigious rate. It is believed that four hydrogen nuclei fuse to form one helium nucleus, subsequently releasing energy in the process. It has been estimated that some 597 000 000 t of hydrogen fuse to form 593 000 000 t of helium every second. Because of the vast quantity of hydrogen present, the sun will continue producing energy at this rate for billions of years. As the hydrogen supply becomes depleted, and the sun's composition becomes less homogeneous, another set of nuclear reactions may cause the sun's luminosity and size to increase so much that the earth will boil away. However, this may occur some four and one-half-billion years hence.

The energy released in the sun's core is transported to the surface by a combination of radiation

and convection. *Convection* is the transmission of heat energy by the physical movement of material; *radiation* is the transmission of energy by photons. Radiation dominates in the interior regions and convection in the outer quarter of the sun's radius, terminating just below the photosphere. In the photosphere, radiation takes over completely. The earth's upper atmosphere receives only about one two-billionth of the sun's radiant energy. About 30% of this is reflected back into space. The remaining portion warms our planet, generates the ocean currents, drives the local and global wind and water cycles, and sustains life.

Only about 0.03% of the incident solar radiation is captured and converted into organic matter by green plants through the process of photosynthesis. Much of this material will eventually decay and thus release its stored solar energy. Over the last six hundred million years or so, a very minute fraction of organic matter has been deposited in oxygen-deficient environments and thus has been preserved in the form of fossil fuels—the so-called nonrenewables. Other sun-dependent energy sources, such as wind, water, and biomass, have been classified as the renewables.

The classification scheme for determining whether or not a particular energy source is renewable or nonrenewable depends on how one wishes to interpret the factors considered in the definition, such as the type of source, the amount present, its rate of consumption, and / or rate of formation, as well as the time scale being dealt with. The fossil-fuel stock is being replenished through processes similar to those that created it in the past, yet at about the same rate as in the past. Thus we could argue that the term "nonrenewable" is inappropriate. But, fossil fuels are being consumed at a far greater rate than their present rate of formation. In several centuries, they may not be available for us to use, but several million years from now, they may possibly be available again.

A similar argument can be developed for biomass energy from trees. We can say that trees replace themselves (reproduce) in a relatively short period of time. Thus, they are a renewable energy source. Yet if the rate of consumption outpaces the rate of replacement, this source of energy effectively becomes nonrenewable. Even the most important source of energy, the sun, will eventually "burn up." Thus, the definitions of renewable and nonrenewable, as well as their applicability, tend to become less clear and may even break down under close scrutiny. For the sake of convenience, the terms renewable and nonrenewable are used to simplify relative comparisons between energy sources for discussion in terms of the everyday world we live in.

The elementary levels of the SEEDS program develop the following major concepts.

1. Our earth is a self-sustaining, self-contained life-support system composed of a large number of environments, or ecosystems.

2. All living things fit into a complex pattern of interrelationships and interdependencies known as food chains.

3. People, as well as all other living things, affect their environment and are in turn affected by it.

4. The sun is the earth's most important source of natural energy.

5. People have in the past freed themselves from a way of life dependent on their own muscle-power and the muscle-power of any animals they were lucky enough to own by using energy from various sources. Modern civilization, and ultimately life itself, will continue only as long as adequate energy sources are maintained.

6. People must change their ways of living to fit changing conditions.

7. The principle of balance is a key to the understanding and wise use of resources.

8. If a natural environment is undisturbed by human beings, it tends to move to a state of equilibrium, or balance.

9. Human beings must disturb the natural balance in order to satisfy their energy needs. However, they should try to establish a new balance, whenever they can. This new balance should be one that supplies their needs while still maintaining the factors that create the needed resources.

10. Individuals should develop sets of values that balance future needs against immediate gains, and social good against private advantage.

Content Summaries

Level 1

The first level of the SEEDS program begins with a consideration of human energy. By performing specified actions, the children learn that energy is what allows people to move. They also discover that some actions use a lot of energy, others only a little. They then classify activities by the amount of energy required to perform them. Then they learn that animals, like people, have energy and that both people and animals eat food to get their energy.

As the activities progress, the children are led to realize that machines use energy too—but their energy comes from other sources, such as electricity and gasoline.

The children then investigate the source of our energy—plants. They learn by experimentation that plants need sunlight, soil, water, and air in order to live and to grow. This leads to a brief discussion of the water cycle and the sun's role in it.

Next the children learn to differentiate between things that are alive and things that are not alive. This leads to a discussion of food chains and how all things interact within environments. This in turn leads to a discussion of how the use of energy—particularly energy from oil and gas—can harm our environment and why we must use energy wisely to make our energy sources last as long as possible and also to protect our environment from the pollution caused by using certain forms of energy.

Level 2

The second level of the SEEDS program begins with a brief recapitulation of important ideas presented in Level 1, with an emphasis on the nature of energy and the importance of the sun as the major source of energy.

From this introduction, Level 2 moves on to an examination of natural environments as opposed to environments that have been largely made by people. The natural environments are balanced, in that energy sources are continually being renewed and are seldom "used up" completely. By contrast, energy sources in environments created by people are used up and must be replaced from outside sources.

Level 2 introduces renewable sources of energy: wind, water, and wood—all of which depend upon the most important source of all, the sun.

The study of wind begins with a definition of wind as moving air. The children observe how moving air does work by seeing how a fan blows pieces of paper about and how curtains move in a breeze. A teacher demonstration with a candle and aluminum-foil strips is used to show the children how the sun causes wind by warming the earth's surface unevenly. Warm air rises and cooler air rushes in producing wind. Children go on to define ways in which people can use wind energy at home, in school, and in the community. They learn that, whenever we can, we should use wind energy in preference to energy derived from nonrenewable sources.

Next, they learn that moving water is another important renewable source of energy. The children themselves perform an experiment to show that moving water has energy. This source of energy comes to us ultimately from the sun since the sun's heat is the moving force in the water cycle. Children discover that people can use energy from moving water in a number of ways, the most important of which is the generation of electricity.

The children then learn that trees are a third important renewable source of energy. They provide us with food energy in the form of nuts, fruit, and so on. Through a teacher demonstration the children feel and see that we also get heat and light energy from burning wood. They learn how wood energy comes ultimately from the sun and that we should use wood energy wisely since trees take a long time to grow to maturity. The children learn to recycle paper as one way of using wood wisely.

The central theme of Level 2 is that using renewable energy sources is preferable to using nonrenewable sources. However, this is not always practical or easy to do. Often the source of energy is not there when we want it. For example if the

wind is not blowing, we cannot use wind energy to move a sailboat. Also, renewable energy sources are sometimes difficult to control. They can even be destructive; as, for example, the wind energy in a hurricane or tornado, the water energy in a flood, or the wood energy in a forest fire.

Level 3

The third level of the SEEDS program begins with a brief recapitulation of important ideas presented in Levels 1 and 2—the nature and sources of energy, the distinction between renewable and nonrenewable energy sources, and the basic concept of conservation (using wisely).

From this introduction, Level 3 moves on to a study of three important nonrenewable sources of energy—coal, oil, and natural gas.

By reading a short passage in their Student Books, the children learn why coal, crude oil, and natural gas are called *fossil fuels*. They learn that fossil fuels are energy from the sun stored in the bodies of plants and microscopic animals that died millions of years ago. In the case of coal, woody green plants were the material that gradually—with time, heat, and pressure—changed into a fossil fuel. Crude oil and natural gas were formed by a similar process from the bodies of plants and tiny animals that lived in the sea. Oil sand is the name given to a solid mixture of crude oil and sand.

Then the children learn that the solid fossil fuels, coal and oil sands, are extracted from the earth by mining. Strip mining and shaft mining are the methods for coal, depending on the location of the coal seams. Crude oil is a liquid fossil fuel. Natural gas is found in a gaseous state. Both are extracted from the earth by drilling. By experimenting with a model, children discover how both mining and drilling can affect the environment. They then identify and evaluate some good and bad effects of these extraction processes.

Fossil fuels must be changed and prepared in various ways before they can be used. The children identify the many different uses of fossil fuels and learn that crude oil, particularly, is used in the making of a great many products including paints, building materials, and plastics. They also learn that all three fossil fuels are used to generate electricity in power plants.

Since the earth's supply of fossil fuels is limited, the children learn that we should try to conserve energy from fossil fuels. Level 3 proposes three different ways of doing this. We should be wise and careful in our use of machines and appliances that get their energy from fossil fuels. We should consider no longer using fossil-fueled machines and appliances that we don't really need. Whenever possible, we should use alternative sources of energy, especially food energy (personal energy).

A related emphasis in the latter part of Level 3 is the wise use of *products* derived from fossil fuels. Avoiding unnecessary waste in this area not only helps to conserve fossil fuels, but also protects the environment (since less garbage is produced).

Level 4

After a brief recapitulation of key ideas presented in earlier levels, Level 4 of the SEEDS program further develops the concept of how we must extract energy sources in order to use them. The children classify various energy sources as renewable or nonrenewable. They examine the flow of energy through food chains—long and short—and investigate the effects of altering the balance of nature.

In the course of their inquiry into solar energy, the children contrast the use of solar heat with the use of heat from a fossil fuel to cook food. They note advantages and disadvantages of the two methods. Through the construction of a solar heater, the children explore the use of the sun's energy to heat air.

Continuing their investigation of renewable energy sources, the children next demonstrate the water cycle and identify important uses of water energy. They also do a demonstration to show what causes wind. Various uses of wind energy are discussed.

Wood is another important renewable source of energy, as well as being the raw material for many useful products such as furniture, lumber for building, pencils, paper, cork, turpentine, and cellulose. During their study of wood, the children note the importance of the sun in the growth of trees and thus in the actual formation of wood.

After exploring some of the advantages and disadvantages of using renewable energy sources, Level 4 moves on to a consideration of three nonrenewable fuels, oil, natural gas, and coal. Extraction methods for oil are examined. The children then investigate the structure and function of pipelines and think about some of the environmental effects of pipeline leaks and oil spills. They also study extraction methods for coal, their effects

on the environment, and the various ways in which land is reclaimed after mining operations have been completed. Good and bad effects of fossil fuel extraction are summarized and evaluated within the context of a simulated "town council meeting."

Level 4 ends with a consideration of ways in which we can use energy wisely.

Level 5

After a brief recapitulation of key concepts presented in preceding levels of the SEEDS program, Level 5 points out that energy may manifest itself in the form of heat, light, sound, or motion. The children are then guided into a further investigation of energy as motion. They learn that energy of motion, or kinetic energy, can be transferred from one object to another. The amount of kinetic energy depends upon the speed and mass of an object. Energy can also be stored and then released later. The students are introduced to the concept of the force of gravity. They deduce how the position and mass of an object are related to its potential, or stored energy.

Next, the children demonstrate how the energy of wind, moving water, and steam can be converted by means of windmills, waterwheels, and turbines. They investigate the methods of generating and measuring electricity. They also classify some forms of energy produced by electrical appliances—mechanical energy, heat energy, light energy.

The children's concept of energy flow through food chains is expanded, and they learn to use the terms *producer*, *consumer*, and *decomposer* in this context. They investigate ways in which energy is lost along food chains, and enlarge their concept of the balance of nature and the interrelationship of all living things.

During their consideration of fossil fuels, the children explore the effects of the conversion of these fuels to electricity. They identify ways in which people use electricity at home and at school, and learn to calculate the amount of electricity used in kilowatt hours. They also study the overall use and importance of petroleum and petroleum products in our society. The refining of petroleum and its effects on the environment are an important part of this study.

Finally, the children are led to think about ways of using energy more wisely. Among these ways are the utilization of short as opposed to long energy chains and the development of practical uses of sulfur, fly ash, propane, and other by-products of energy conversion processes. Simulated case studies give the children opportunities to evaluate pros and cons, and make some energy-related decisions of their own.

Level 6

After a brief review of key concepts developed to this point in the SEEDS program, Level 6 leads the children into a consideration of energy use in the processing, preserving, and packaging of foods. These activities not only use a great deal of energy, but also have serious environmental effects. In particular, throwaway containers are investigated.

The children study methods of garbage disposal. They suggest alternatives to intensive packaging, and ways of reusing waste products. They distinguish between *reusing* (using an object again in the same form for a different purpose) and *recycling* (changing an object's form so it can be made into a new and different product). They discuss ways of avoiding waste.

Level 6 then moves on to an investigation of the automobile as one of the leading energy-consumers in our society. A great deal of energy is used in the manufacture of automobiles. Automobiles require a large amount of energy from fossil fuels in order to run. The children identify and evaluate the effects of automobile use, both on the environment and on society in general.

They think about ways of recycling material from old automobiles. They also learn to calculate the fuel efficiency of automobiles, and suggest possible reasons for greater or less efficiency in particular cases. In conclusion, the children are encouraged to distinguish between needs and wants, with a view to eliminating or reducing the use of energy-consumers that are luxuries rather than necessities.

Additional Investigations

The Additional Investigations are short, hands-on activities that have been prepared to enhance the acquisition of science process skills. They are especially suitable for use when SEEDS is taught as part of a core science curriculum. Each investigation is correlated to one or more activities in the core materials. The following tables of contents indicate the topics investigated.

Additional Investigations 4

1 How Much Energy Can We Save?
2 What Will Happen to a Pond-water Ecosystem that Has No Light?
3 How Much Warmer Does a House Facing South Get than a House Facing North?
4 Which Stores Solar Energy the Best—Sand, Water, or Paper?
5 How Much Pure Water Can Be Obtained from 1 L of Muddy Water, Using a Solar Still?
6 How Much Faster Does a Sample of Warm Oil Flow than a Sample of Cold Oil?
7 What Are the Properties of Coal?

Additional Investigations 5

1 How Many Candles are Needed to Boil 10 mL of Water?
2 What is the Best Lightbulb You Can Make?
3 What Conditions are Best for Growing Bread Mold?
4 What Kinds of Particles Are in the Air Outside?
5 How Fast Can Water Be Heated with a Piece of Wire and a Generator?
6 How Much Faster Does Alcohol Evaporate than Water?
7 Will a Four-blade Propeller Lift Twice as Many Washers as a Two-blade Propeller?

Additional Investigations 6

1 How Much Energy Does a Peanut Have?
2 Can We Save Energy by Sun-drying Grapes?
3 What Do You Get When You Burn Garbage?
4 Why Does a Tin Can Rust?
5 How Does Nature Recycle Organic Waste?
6 What's Happening to a Fallen Tree?
7 How Far Will an Elastic Band Stretch Before It Moves Different Masses?
8 Do Some Cars Pollute More than Others?
9 Will Water Boil Faster in a Covered or an Uncovered Pot?
10 How Can You Cook a Hot Dog Using Solar Energy?

Core Objectives and Skills

Method of Listing Objectives in SEEDS 1—6

The pedagogical goal of the SEEDS program is not only to foster the development of understanding and thinking processes with regard to energy and the environment but also to promote attitudinal learnings that will manifest themselves in positive actions, feelings, and values. Both kinds of objectives—cognitive and attitudinal—are included among those listed at the beginning of each activity in the Teacher's Guide.

The objectives are listed in as specific a manner as possible, using concrete verbs such as *demonstrate, compare, contrast, classify, explain, recognize, investigate,* and *examine.* There are several reasons for listing the pedagogical objectives so specifically at the beginning of each activity:

1. A clear statement of objectives can help the teacher to assess whatever skills and knowledge the children may already have.

2. Some of the objectives listings may actually be presented to the children themselves rather than serving as teacher information only, especially at levels 4—6. Understanding the objectives of a particular activity can help the children to focus upon the desired outcomes of the activity.

3. The listing of educational objectives can help teachers to plan additional learning experiences in conjunction with particular activities, if they wish to do so.

4. The objectives listings are an important aid in evaluation of the children's learning. This point will be discussed in greater detail later.

The following pages show the core objectives charted by organizing concept.

Energy Literacy Objectives Levels 1, 2, and 3

ORGANIZING CONCEPTS	SPECIFIC CONCEPTS		
	LEVEL 1	LEVEL 2	LEVEL 3
The Nature of Living and Nonliving Things	5. Distinction between living and nonliving things. 6. Some characteristics of living and nonliving things. 14. Main parts of a plant.	16. Main parts of a tree.	
The Nature of Energy	2. Energy seen as motion. 15. The sun's energy—seen as light. 17. The sun's energy—felt as heat.	1. The term *energy*.	1. The term *energy*.
Uses of Energy	1. Food energy allowing humans to walk, run, and play. 3. Use of energy by people—to move. 4. Use of energy by other living things—to move. 7. Use of energy by machines — to move, to produce heat, and to produce light.	2. Some common sources and uses of energy. 8. Examples of wind-energy use. 12. Examples of use of energy from moving water. 18. Examples of use of energy from burning wood.	2. Some common sources and uses of energy. 12. Some uses and products of fossil fuels.

	LEVEL 1	LEVEL 2	LEVEL 3
Sources of Energy—Renewable and Nonrenewable	8. Energy for people from eating food. 9. Energy for other living things—from food. 10. Energy for machines—from gasoline or from electricity. 11. Plants' need of sunlight, soil, water, and air in order to live and to grow. 12. Energy for people—from eating plants. 13. Energy for other living things—from eating plants. 21. Energy for people—from eating animals and animal products. 22. Energy for other living things—from eating animals.	2. Some common sources and uses of energy. 5. Some renewable energy sources. 7. Energy in wind. 11. Energy in moving water. 17. Trees as a source of energy.	2. Some common sources and uses of energy. 5. Fossil fuels as most commonly used source of energy today. 6. Fossil fuels as energy from the sun, stored in the bodies of plants and tiny animals that died millions of years ago. 9. Three forms of fossil fuels: solid (coal and oil sand), liquid (crude oil), and gas (natural gas). 14. Distinction between renewable energy sources (such as wind, water, and wood) and nonrenewable energy sources (such as coal, oil, and natural gas).
The Importance of Energy from the Sun	16. Plants' need of the sun's energy to produce food. 18. The sun's heat as the moving force in the production of water and plants' need of water to produce food. 24. Living things' need of the sun's energy to live and to grow.	3. The sun as the most important source of natural energy. 6. The sun's role in the production of wind. 10. The sun's role in the production of water. 15. The sun's role in the production of wood.	3. The sun as the most important source of natural energy.

	LEVEL 1	LEVEL 2	LEVEL 3
The Interrelationship of all Living Things with Each Other and with their Environment	19. Interaction of plants and animals with their surroundings. 20. Interaction of people with their surroundings. 23. A "food chain" as showing energy flowing from one living thing to another.	4. Distinction between a natural environment and an environment made by people.	19. The use of fossil fuels and their products as affecting the environment in serious ways.
Wise Use of Energy and Natural Resources	25. Wise use of food. 26. The basic concept of conservation—saving through wise use. 27. Wise use of energy from electricity. 28. Wise use of energy from oil and gasoline.	9. Wise use of wind energy. 13. Wise use of electrical energy from moving water. 14. The basic concept of conservation—saving through wise use. 19. Limited supply of energy from wood. 20. Wise use of energy from wood. 21. Use of both energy and trees in making paper. 22. Recycling of paper.	4. The basic concept of conservation—saving through wise use. 15. Limited supply of fossil fuels. 16. Examples of use of fossil fuels. 17. Distinction between needs and wants. 18. Ways of saving fossil fuels by using only those machines, appliances, and products that are really needed. 20. Ways of using alternative sources of energy, especially energy from food.
Extraction, Conversion, and Distribution of Fossil Fuels			7. Extraction of fossil fuels. 8. Processes for extracting coal. 10. Processes for extracting crude oil and natural gas. 11. Preparation and conversion of fossil fuels. 13. Beneficial and harmful effects of fossil fuel extraction.

Energy Literacy Objectives Levels 4, 5, and 6

ORGANIZING CONCEPTS	SPECIFIC CONCEPTS		
	LEVEL 4	LEVEL 5	LEVEL 6
Sources of Energy—Renewable and Nonrenewable	1. People's need for energy sources. 3. Coal, oil, and natural gas as fossil fuels. 5. Energy sources as renewable or nonrenewable. 12. The renewable qualities of solar energy. 13. The water cycle. 16. The wind cycle. 20. Comparison of qualities of wood to the qualities of fossil fuels. 22. Distinction between two kinds of oil deposit—surface and underground.	1. People's need for energy sources. 3. Coal, oil, and natural gas as fossil fuels.	1. People's need for energy sources. 3. Coal, oil, and natural gas as fossil fuels.
The Importance of Energy from the Sun	2. The sun's role in the formation of energy sources. 11. The sun as a source of energy for heating. 14. The role of the sun in creating water. 17. The role of the sun in creating wind. 19. The role of the sun in the growth of trees.	2. The sun's role in the formation of energy sources.	2. The sun's role in the formation of energy sources.

	LEVEL 4	LEVEL 5	LEVEL 6
Uses of Energy	6. Ways in which various energy sources are used during daily activities. 7. Daily energy uses dependent on renewable and nonrenewable sources of energy.	24. Electrical appliances as consumers of energy. 25. The major consumers of electricity in the home. 26. Amounts of energy used by these consumers in kilowatt hours. 27. The major consumers of electricity in the school. 34. Our dependence on fossil fuels to maintain our lifestyle. 35. Our current rate of petroleum consumption.	38. Use of the automobile as determined by our current lifestyle. 39. The relative proportion of family driving devoted to shopping, pleasure, and work. 40. The amount of fuel required for normal automobile use.
The Interrelationship of all Living Things with Each Other and with their Environment	8. The interdependence of elements within the natural environment. 9. Comparison of food chains according to amount of energy used. 10. Ways in which the flow of energy between producers and consumers can be affected, altering the balance of nature.	18. The basic elements of a food chain. 19. The flow of energy through producers, consumers, and decomposers in a food chain. 20. The term "balance of nature". 21. Some elements of one type of ecosystem—how they affect one another in maintaining the "balance of nature".	
Wise Use of Energy and Natural Resources	4. Comparison and contrast of the relative advantages and disadvantages of using sunlight as an energy source with the use of fossil fuels as an energy source. 33. Ways in which individuals waste energy. 34. Wise use of energy. 35. Ways in which individuals can use energy wisely.	36. Wise use of energy derived from oil and other fossil fuels. 37. Long and short conversion chains. 38. Long and short conversion chains in terms of their energy use and effect on the environment. 39. Shorter chains as using less energy and producing less waste than long chains.	15. Alternatives to modern packaging techniques. 16. Ways in which waste products can be reused. 17. Reuse of waste products to help reduce the demand for energy. 18. Differentiation between the concepts *recycle* and *reuse*. 19. Recycling of "waste products" in nature.

		44. Choice of an appropriate course of action according to the analysis of a given situation. 45. Extension of energy conversion chains by using energy to manufacture consumer goods and process foods.	20. Recycling of waste products to help reduce the demand for energy. 21. Ways in which waste products can be recycled. 22. The actions necessary to conserve energy. 23. Projects that illustrate alternatives for energy use. 24. Energy-conservation practices. 34. Possible ways to decrease air pollution caused by automobiles. 36. Possible ways of recycling scrapped automobiles. 41. Distinction between "needs" and "wants". 43. Ways in which energy is wasted when it could be conserved.
The Nature of Energy		4. Use of energy when change occurs, or when heat, light, or motion is observed. 5. Heat, light, sound, motion, and electricity as forms of energy. 6. Heat, light, sound, and motion as forms of energy. 7. Kinetic energy as transferred from one object to another. 8. Kinetic energy as dependent on the speed and mass of an object. 9. Storage and retrieval of energy to perform work. 10. Use of gravity to do work. 11. Relationship of height and mass.	

	LEVEL 4	LEVEL 5	LEVEL 6
Extraction and Distribution of Fossil Fuels	23. Extraction methods for each type of oil deposit. 24. A model pipeline. 25. Problems in pipeline construction. 26. Distinction between two kinds of coal deposits—surface and underground. 27. Extraction methods for each type of coal deposit. 30. The different points of view that people in a community have with regard to extraction and development of energy sources. 31. Merit of all points of view. 32. Decision to develop or not develop an energy source in a town setting.		
Environmental Effects of Extraction and Development of Energy Sources	21. Specific environmental changes caused by developing renewable sources of energy. 28. The environmental impact of surface coal mining. 29. The effects of surface coal mining on the "web of life".		
Energy Conversion	15. The means of harnessing the energy of water. 18. The means of harnessing the energy of wind.	12. A model turbine wheel. 13. Water converted to steam doing work. 14. Form of energy produced by electrical appliances.	

		15. Electrical energy converted to heat, light, and mechanical energy. 16. The steps required to produce electricity from coal. 17. Dissipation of heat into the environment in the conversion process. 28. The steps required to produce gasoline from petroleum. 29. The main products of petroleum refining. 40. By-products from energy conversion processes. 41. Uses for these by-products. 42. Uses for other by-products.	
Environmental Effects of Conversion and Use of Energy and Energy Sources		22. Major by-products of the fossil-fuel-to-electricity energy-conversion process. 23. The effects of these by-products on the environment. 30. The environmentally harmful by-products of petroleum refining. 31. Prevention of this pollution. 32. The burning of oil products as a major cause of pollution. 43. Possible effects on the environment of some processes used to convert energy form renewable and nonrenewable sources.	

	LEVEL 4	LEVEL 5	LEVEL 6
Consumption of Energy and Energy Sources in the Manufacture, Packaging, and Use of Consumer Goods		33. Petroleum-based products.	4. Expenditure of energy in the manufacture and use of consumer goods. 5. Food processing and packaging as energy consumers. 6. Processing and packaging of foods necessary for their preservation. 7. The energy-consuming steps in processing a breakfast cereal and producing a cereal package. 9. The energy-consuming steps in the manufacture, use, and disposal of nonreturnable containers. 13. The sources of energy used in various packaging techniques. 14. Packaging techniques as determined by our current lifestyle. 25. The history of the automobile. 27. The energy-consuming steps in the life of an automobile. 28. An Auto Log. 29. Some petroleum products used in the maintenance of automobiles. 30. Some materials used in the manufacture of automobiles. 31. Comparison and contrast of the relative energy-intensiveness of different vehicles.

Environmental Effects of Producing, Using, and Disposing of Consumer Goods			8. The effect on the environment of the use of nonreturnable containers. 10. The amount of waste generated from the packaging of consumer goods. 11. The main methods of solid-waste disposal. 12. The effect on the environment of the disposal of solid waste. 26. Some of the effects on the environment of the use of the automobile. 32. The pollutants emitted by automobiles. 33. The effects on air quality caused by our use of automobiles. 35. The solid-waste disposal problem created by scrapped automobiles. 37. The effects on the environment of the use of the automobile.

The Cognitive Objectives

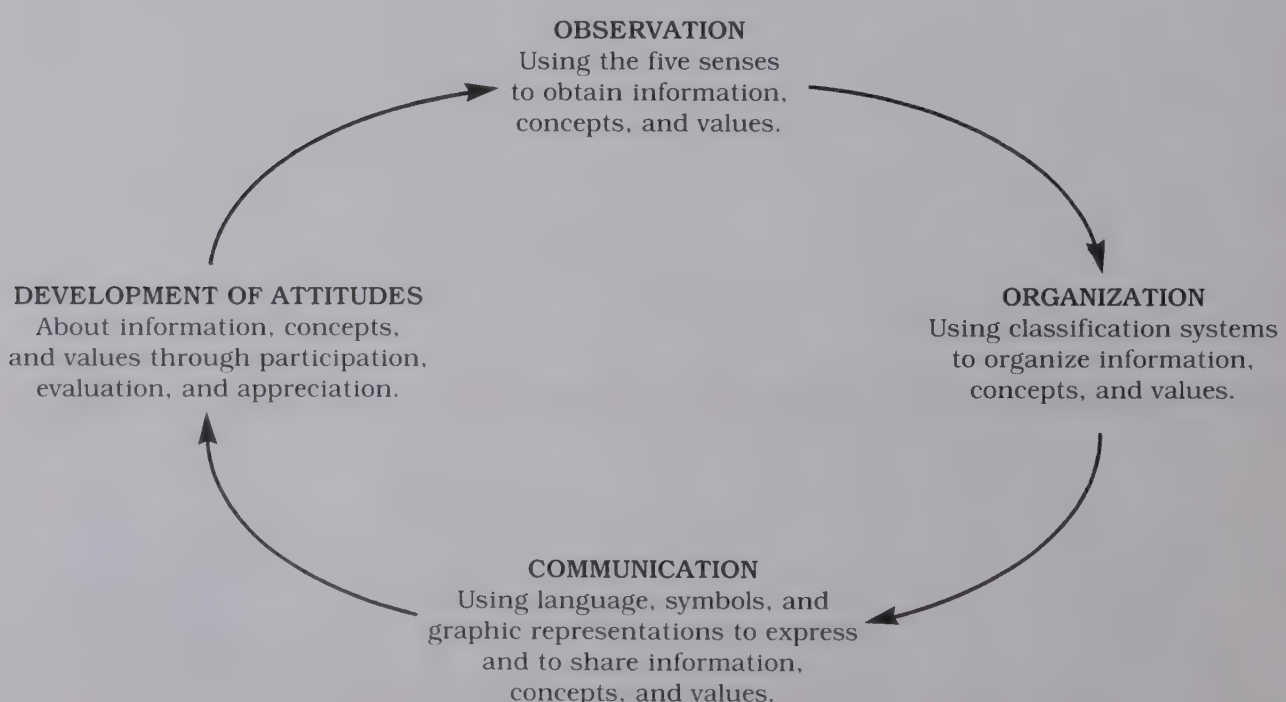
The developers of the SEEDS program have planned the series to assist children in applying rational and scientific thinking processes to energy facts and issues as we know them today. However, it is also hoped that the concepts and thinking skills gained through the series may serve as a springboard for the students in acquiring new energy knowledge and in attacking new energy problems in the future. In our rapidly changing world, children must learn *how to learn*. In order to be effective, well-adjusted members of society, they will need to become lifelong learners.

The following is a partial listing of important thinking and learning skills developed in levels 1—6 of the SEEDS program.

- Observing data carefully and accurately.
- Understanding cause and effect relationships.
- Seeing similarities and differences.
- Following order of events; understanding processes.
- Measuring.
- Collecting and organizing information with a specific purpose in mind.
- Making inferences.
- Drawing conclusions.
- Predicting outcomes.
- Evaluating information, ideas, and opinions.
- Finding evidence or proof.
- Reorganizing information into new configurations.
- Presenting information and ideas in clear accurate language, both spoken and written.
- Presenting information in pictorial or graphic form.

Some of the cognitive skills developed in levels 1—6 are reflected in the objectives listings found at the beginning of each activity in the Teacher's Guide. Others, though not specifically listed, can be drawn from the activities themselves to suit individual classes. In levels 1—3 there is an emphasis on direct perception of data through observing, listening, and doing. The broader-category skills such as classifying quantities of data, making inferences, and reorganizing information receive a greater emphasis in levels 4—6.

As the following chart shows, the main learning, thinking, and valuing skills form a circle, each leading to the next. The skills charts on the following pages are organized under these main skills. Specific process skills are charted separately.


OBSERVATION
Using the five senses to obtain information, concepts, and values.
ORGANIZATION
Using classification systems to organize information, concepts, and values.
COMMUNICATION
Using language, symbols, and graphic representations to express and to share information, concepts, and values.
DEVELOPMENT OF ATTITUDES
About information, concepts, and values through participation, evaluation, and appreciation.

Learning, Thinking, and Valuing Skills Levels 1, 2, and 3

C indicates Core Activity
X indicates Extension Activity
N indicates Enrichment Activity

GENERAL CATEGORIES	SPECIFIC SKILLS	LEVEL 1	LEVEL 2	LEVEL 3
OBSERVATION: using the five senses to obtain information, concepts, and values	By listening to a story	C1 C3 C7 C16 C17	C2 C4 C11	C3 C5
	By viewing an audio-visual presentation	C6 C14 C20	C1 C3 C5 C7 C11 C15	C1 C7 C8 C10 C11 C15
	By viewing pictures	C1 C3 C4 C7 C8 C15 C16 C17 C18	C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C13 C14	C1 C3 C4 C5 C6 C7 C8 C11 C12 C13 C14 C15
	By participating in physical activity (role-playing, manipulating objects . . .)	C1 C2 C11 C12 C19	C4 X4 C5 X6 C9 C10 X11	N2 C3 C5 C8 C9 C10 X10 X12 C13
	By observing data carefully and accurately (in naturally occurring situations, classroom demonstrations, experiments . . .)	C4 X1 X3 X4 C7 C8 C9 C10 C11 C12 C13	C4 X4 C6 X8 C10	X2 C5 X5 C6 X7 C10 X10
	By recalling relevant personal experiences and observations	C5 C6 C7 C8 C16	C3 C4 C7 C9	C7 X7 C8 C10
	By reading simple written language	(optional for Level 1)	C2 C3 C5 C6 C7 C8 C9 C10 C11 C12 C13	C2 C3 C4 C5 C6 C7 C8 C9 C10 C12 C13 C14 C15
	By doing research		X10	X6 X7 X14

		LEVEL 1	LEVEL 2	LEVEL 3
ORGANIZATION: using classification systems to organize information, concepts, and values	By recognizing similarities and differences	C1 C4 C5 C9 C11 C12 C13	C2 X2 C5	C5 C10
	By recognizing cause-and-effect relationships	C1 C3 C5 C9 C10 C11 C15	C4 C6 C7 C9 C11 C13	C3 C6 C8 C10 C12
	By following a sequence of events: by recognizing processes	C2 C11 C14 C15 C19	C3 C4 C5 C6 C7 C9 C12 C13	C3 C4 X5 C7 C8 C12 C13
	By drawing conclusions	C1 C5 C10 C11	C2 C3 C4 C6 C10 C11 C13 C14	C1 C6 C8 C9 C10 X10 C13 C14
	By predicting outcomes	C5 C9 C15	X4 C6 C10	C8 C10 X10 C13
	By giving reasons	C9 C10 C12 C13 C16 C17	C7 C9 C10	C2 C5 X12 C13
	By developing key concepts and appropriate corresponding vocabulary	C1 C2 C3 C4 C8 C12 C15 C17	C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C12 C13	C1 C2 C3 C4 C6 C7 C8 C9 C10 C13
	By collecting and / or classifying pictures under main headings or in categories	X1 N2 C5 C6 C13 C14 C18 C19	N1 C7 C13	N1
	By classifying objects or pictures to show similarities and differences	C2 C3 C4 C12 C14 C15	C2 X2 C3 C9	C3 C14
	By recognizing symbolic representations and models	C8 C9 C19	C4 C6 X6 C11	C5 C6 C8 C10 X10

	By comparing data	C1 C2 C3 C6 X9 C10 C11	X8	C5 C10 X10
	By counting number of occurrences			C10 C11
COMMUNICATION: using language, symbols, and graphic representations to express and share information, concepts, and values with others	By using oral language in informal discussion	All C Activities; most N and X Activities	All C Activities; most N and X Activities	All C Activities; most N and X Activities
	By using simple written symbols (circles, X's, lines, initial letters . . .)	C2 C3 C4 C6 C8 C9 C11 C12 C14 C15 C18	C2 C3 C7 C8 C11 C13 C14	C6 C8 C11 C13
	By preparing illustrations that demonstrate understanding	N5	N10 N12	N14
	By using simple written language		C4 C6 X8 C9 N11 C13 C14	C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C12 X12 C13 N14 C15
	By preparing charts and diagrams		X10	C5 X6 C10 C11 X14
	By constructing representational (concrete) models			X4 X6 X14
DEVELOPMENT OF ATTITUDES: about information, concepts, and values through participation, evaluation, and appreciation	By proposing appropriate actions and solutions (social and values issues)	X7 C16 C18	C10 C11	C10 C11 C13 C14 X14
	By creating a plan of action	X7 C16	C5	C11 C14
	By applying a chosen plan of action	X7	C5	C14
	By evaluating actions and solutions (social and values issues)	X7 C16	C11	C9 C13 C14 N14
	By judging worth of consequences	C17	C8 C11	C9 C13

	LEVEL 1	LEVEL 2	LEVEL 3
By formulating alternative proposals (social and values issues)	X7	C11	C13 C14
By participating in group activities (projects, games, singing)	X7 N8 C9 C12 C14 C19	C7 N11 C12 C14	C9 C10 X10 C11 C13 X14
By recognizing personal responsibility	C17 C18	C8 C11 C12 C14	C10 C11 C13 C14 C15
By appreciating and responding to artistic expression of ideas in poems, songs, stories . . .	N5 N8 N11 N14	N3 N6 N11	N4

Learning, Thinking, and Valuing Skills Levels 4, 5, and 6

C indicates Core Activity
X indicates Extension Activity
N indicates Enrichment Activity

GENERAL CATEGORIES	SPECIFIC SKILLS	LEVEL 4	LEVEL 5	LEVEL 6
OBSERVATION: using the five senses to obtain information, concepts, and values	By viewing an audio-visual presentation	C1 C2 C6 C8 C9 C12 C14 C18	C1 C4 C5 C12 C14 C18	C1 C7 C11 C19
	By viewing pictorial representations	Most C Activities	Most C Activities	Most C Activities
	By participating in physical activity (roleplaying, manipulating objects, doing experiments . . .)	C3 C6 C7 C8 C9 X10 C13 X14 C16 X16 X17	C2 C3 C4 X5 C7 C10 X10 X15 C17	X5 X6 C9 X9 X10 C11
	By observing data carefully and accurately (in naturally occurring situations, classroom demonstrations, experiments . . .)	C3 C7 C8 C9 X10 C13 X15	C2 C3 C4 X6 C8 X10 X11 C14	X2 X4 X5 X6 X8 X9 X10 X12 X14
	By recalling relevant personal experiences and observations	C4 C7 C8 C10	C1 C2 C5 C6 C8	C2 C4 C6 C8 C10 C13 C17
	By reading written language	All C Activities: some X and N Activities	All C Activities: some X and N Activities	All C Activities: some X and N Activities
	By doing research	X5 X11 X14 X17	X3 X7 N7 C10 X11	C12 X12 X14 X15

		LEVEL 4	LEVEL 5	LEVEL 6
ORGANIZATION: using classification systems to organize information, concepts, values	By recognizing similarities and differences: by making comparisons	C3 C4 C5 C7 X10 C14	C2 C5 C6 C7 C15 C18	C3 C4 C5 C7 C8 C9 C13 C17 C18
	By recognizing cause-and-effect relationships	C1 C5 C6 C8 C9 C13 C18	C1 C2 C3 C4 C5 C6 C7 C8 C18	C6 C9 C17 C18 X18
	By following sequence of events: by recognizing processes	C1 C5 C6 C8 C9 C13 C14 C18	C2 C3 C4 C5 C6 C8 C11 C12 C15 C16 C18	C2 C3 C4 C6 C9 C12 C13 C18
	By giving reasons	C1 C3 C9 C14 C17	C1 C2 X5 C6 C7	C1 C2 C10 C11 C16
	By classifying objects, pictorial representations, etc. under main headings or in categories	N2 C6 C17	C5 C13 X13	C2 C4 C5 C11 C13 C17 C18 X18
	By classifying objects, pictorial representations, etc. to show similarities and differences	C3 C4 C5 C6 C7	C8	
	By recognizing symbolic representations and models	C6 C8 C9 C13	C4 C5 C7 C14	X6
	By recognizing main ideas	C1 C2 C6 C9 C10 C14 C15 C17 C18	C1 C2 C3 C7 C18	C1 C6 C7 C12 C16 C19
	By drawing conclusions	C1 C7 C9 C13	C3	C7 C10
	By developing key concepts and appropriate corresponding vocabulary	C1 C2 C5 C6 C7 C8 C10 C11 C12 C13 C14 C15	Most C Activities	Most C Activities

By recognizing relationships (numerical, simple ratio and proportion)	C5	N7 X7 C14	C17
By measuring	C3 C7	C14	X14
By making calculations		C9 X9 C10 X10	C17
By drawing on previous personal experiences and observations in order to make inferences	C1 C4 C5 C6 C7 C10 C14	C1 C5 C6 C15	
By speculating about or inferring probable reasons	C9 C13	X10	C7 C9 C17
By speculating about or inferring probable cause / effect relationships	C9 C10 C11 C15	C8 C12	C6 C14 C16
By speculating or making inferences about sequences of events; processes	C5	C5 C6	C6 C15
By making inferences based on and including (hypothetical) situations	C5 C17	C6 C13	C1 C6 X14 C16 X16
By speculating about meanings of unfamiliar words	C13	C6 C8 C11	
By predicting probable sequence of events	C5		
By predicting probable outcomes, effects, and / or results	C3 C4 C6 C13 C15 C17	C2 X5 C6 C7 C14	X6 C16
By proposing appropriate actions based on prediction of outcome	C17	C14 N14	C10
By predicting possible future developments (in society . . .)	C9 C10	C14 N14	C1 C10 C16

		LEVEL 4	LEVEL 5	LEVEL 6
COMMUNICATION: using language, symbols, graphic representations to express and share information, concepts, and values with others	By using oral language in informal discussion	All C Activities; many X and N Activities	All C Activities; many X and N Activities	All C Activities; many X and N Activities
	By using oral language in formal interviews, meetings, speeches	X4 C16 X16 X17	C17	X5 X6 X10
	By preparing pictorial representations that demonstrate understanding	C13	N2 X3 N6	X12 C15
	By completing and / or making charts and diagrams	C3 C4 X4 C5 C6 C7 C8 X9 X10 C11	X3 X6 C8 C10 C14 C16	C2 X2 C3 C5 X6 C7 C8 C11 C12 X12 X14 C16 C17
	By indicating features on a map	X2 X10	X5	
	By using symbolic representations	X2		
	By constructing representational models	C13	C4	X6
	By using written language	Most C Activities; many X and N Activities	Most C Activities; many X and N Activities	Most C Activities; many X and N Activities
	By preparing oral and / or written summaries, reports, paragraphs . . .	C3 C13 X14 C16 C17	X3 N13 N14	C4 X5 C11 X12 X14 X16
	By writing letters			X3 X5

DEVELOPMENT OF ATTITUDES: about information, concepts and values through evaluation, participation, and appreciation	By proposing appropriate actions and solutions (social and values issues)	X5 C7 C13 C17	X10 C13 C14 N14 C15	C5 C6 X8 C11 C14 C15
	By evaluating actions and solutions (social and values issues)	C9 C11 C13 C15 C16 C17	X10 C15 C17 X17	C6 C7 C10 C14 C18 X18
	By judging worth of consequences	C7 C11 C13 C16 C17	X10 C15 C17 X17	C6 C7 C10 C11 C18
	By creating a plan of action	C17	X10	
	By applying a plan of action		X10	X3 C11
	By participating in group activities (projects, experiments, meetings, games . . .)	C3 C6 C7 C8 N10 C13 C16	C2 C3 C4 C7 X10 C17	X8 C9 C11 C15
	By recognizing personal responsibility	X5 C7 C17	X10 C13 X13 C14 N14 C15	C1 X8 X9 C11 C18 X18
	By appreciating and responding to artistic expression of ideas in poems, songs . . .	N2 N10		

SPECIFIC PROCESS SKILLS
Additional Investigations Levels 4, 5, and 6

PROCESS SKILL	LEVEL 4	LEVEL 5	LEVEL 6
Observing	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7 8 9 10
Measuring	3 4 5 6	1 2 4 5 6 7	1 2 6 7 8 9 10
Classifying	4 7	8	3 6
Communicating	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 8 9
Inferring	1 2 3 4 5 6 7	1 2 3 4 5 6	1 2 4 5 6 7 8 9 10
Predicting	4 6	6 7	1 3 4 5 6
Identifying and Controlling Variables	1 2 3 4 5 6	1 2 3 4 5 6 7	1 2 3 4 7 8 9 10
Collecting and Interpreting Data	1 2 3 7	5	3 5
Defining operationally	2 7		7
Formulating Hypotheses		2 3	4 8 9 10

The Attitudinal Objectives

An attitude may be defined as a predisposition to act in a certain way with regard to objects, persons, and ideas. Attitudes are, of course, related to knowledge. However, they also have a connection with emotions and feelings. The goal of the education system is not to induce all children to adopt exactly the same set of attitudes and values. Rather, it is to help children understand the sources of their values and attitudes, to alert them and to encourage them to act and behave in accordance with their chosen attitudes and values.

With specific reference to energy and environmental education, the SEEDS program attempts to cultivate the following positive attitudes and values.

- Being concerned for other people for the common good.
- Recognizing one's personal responsibility to the society in which one lives.
- Recognizing one's responsibility for one's environment, and attempting to live in harmony with that environment.
- Conserving energy, natural resources, and manufactured products; avoiding waste of any kind as a matter of principle.
- Recognizing the complexity of energy issues and maintaining an open mind with regard to differing viewpoints and new information that one may encounter in the future.

An attitudinal objective in the SEEDS program is usually linked with an opportunity for the children to exhibit behaviors and / or carry out practical actions arising naturally from that objective. For example, in Activity 7 of Level 1, the children consider ways of helping other people. The teacher then guides them in actually carrying out their plans for helping specific real individuals in their families or community. In Activity 9 of Level 6, the children discuss how waste can be reduced through recycling. They then actually go through the process of recycling waste paper in order to make new sheets of usable paper.

Integrating SEEDS with the Elementary Curriculum

Relationship of SEEDS to Science, Social Studies, and other Subject Areas

By their very nature, the topics of energy and the environment relate to almost everything we do. Thus, in one sense, the teaching of energy literacy and environmental studies should be thought of as an integral part of the curriculum—to be drawn in whenever appropriate no matter what subject area is officially being considered.

However, in practical terms, following this approach exclusively often results in a somewhat fragmented treatment characterized by serious omissions and undesirable overlaps from one level to another. The SEEDS program, with its comprehensive scope and carefully planned progression of learning experiences, provides a solid foundation and focus for effective energy and environment education as part of a science or social studies curriculum or on its own as an independent energy curriculum.

The SEEDS program is essentially an interdisciplinary one. The most prominent subject areas identified within it are science and social studies. The scientific and social aspects of energy and environment issues are closely linked. A serious consideration of these issues requires the information, skills, and attitudes taught in both disciplines.

The practise of centering learning on particular problems—drawing in data and skills from a wide range of disciplines as needed—is widely accepted in educational circles today and is particularly applicable to the elementary levels. The SEEDS program, while drawing most heavily on the subject areas of science and social studies, also brings to bear knowledge and skills from a wide range of other disciplines, including language arts, mathematics, health education, music and art. These other disciplines are integrated in various ways within the Core Activities themselves. The Extension and Enrichment Activities indicate the particular subject area. The Additional Investigations provide an opportunity for children to further apply science process skills.

Practical Suggestions on Scheduling and Timetables

Each school, and even each class within a school, is different in interests, background, and specific learning needs. It is therefore inappropriate to be prescriptive about the way in which the SEEDS program can best be incorporated into the schedule. However, the program is designed to provide approximately four to six weeks of study.

Almost any time of the school year would be appropriate for the SEEDS program. However, a time period when relatively good weather can be expected would be preferable, since many of the learning experiences relate directly to the outdoor environment. Another consideration—with regard to Level 1—would be the limited experience and reading ability of the children during the early part of the year. For these children the program might best be scheduled sometime during the second half of the year.

With regard to timetable adjustments for particular classes, the suggestions given here cannot be prescriptive since situations vary so greatly. As a rule, it is probably best to schedule a definite amount of time per day or week for the SEEDS program, while still allowing for some flexibility, if possible. If the actual amount of time remains flexible, the children will almost always have the satisfaction of completing investigations of projects without being interrupted. Sometimes a longer period can be crucial to the gaining of a particular concept or insight.

At the beginning of each activity in the SEEDS Teacher's Guide, the teacher is informed of the length of time likely to be taken not only by the basic Core Activity, but also by any Extension or Enrichment Activities that follow. Generally, the time suggested for Activities increases gradually from level to level within the series. The shorter attention span of younger children has been especially taken into account in Levels 1—3. The activities are shorter in these primary levels. There are also more frequent switches from listening to talking to demonstrating to reading to writing, and so on within an activity.

The following are some overall considerations and principles that administrators and teachers may wish to keep in mind as they plan their timetables with reference to the SEEDS series.

1. One possibility for the SEEDS program is that it be scheduled for periods usually given to science and social studies. The time of day is not crucial in many cases. However, if the children have been asked to bring something from home to show the class, it may be best to schedule the related activity for the first period of the day. Primary children, especially, may be anxious to share information about what they have brought immediately.

2. The SEEDS program, Levels 1—6, does not require much use of special rooms or special facilities within the school. Since an average classroom with the usual equipment will suffice for most of the activities, the need for complicated meshing of schedules among teachers is kept to a minimum.

3. In some cases it may be helpful to appoint a SEEDS program coordinator for the school. (Such a person could not only assist teachers in planning timetables, but could also perform such valuable services as investigating local community problems and resources with regard to energy and the environment.)

4. Team teaching of the SEEDS program or parts of it may be worth considering as a possibility. In this way teachers with special knowledge and capabilities in the area of energy and environment education could share their expertise with more than one class within the school.

Teaching Strategies Used to Present and Develop Concepts

The "Guided Discovery" Approach

Some science and social studies curricula strongly emphasize processes of inquiry such as observing, describing, measuring, classifying, inferring, and predicting. Others are based on the idea that science and social studies are essentially organized bodies of subject matter. In actual fact, both *processes* and *subject matter* are important. There is a place in the study of science and social studies for both experimentation and reading. Children cannot learn everything from experimentation and firsthand experience. On the other hand, it is important for children to practise processes of inquiry and develop the attitudes of scientifically-minded persons. Scientific processes and attitudes can be transferred to other subject areas, and are valuable as a basis for learning of any kind.

The SEEDS program uses both "telling" and discovery as strategies for the presentation and development of concepts—the "guided discovery" approach. The strategy used in a particular core depends upon such factors as the subject matter under consideration, the probably availability of suitable equipment, and the relative maturity of the children. However, there is in general a stronger emphasis on the discovery approach. It should also be noted that the "discovery approach" may take either an *inductive* or a *deductive* form.

In the inductive form or pattern of discovery, children might make certain observations, form hypotheses based on these observations, and then experiment to test the validity of their hypotheses. In the deductive form, on the other hand, the children might be presented with a generalization first (rather than with a set of observations). They would deduce certain consequences from this generalization. Then they would conduct a suitable experiment and compare its results with the consequences that they had previously deduced. Children might also suggest experiments themselves, following similar methods of investigation.

The following are some practical guidelines for the classroom implementation of the experiments, demonstrations, investigations, and other "guided discovery" experiences suggested in the SEEDS program.

1. As far as possible, allow the children to plan and organize the experiments, making their own predictions about what might happen and drawing their own conclusions about the results.

2. Keep experiments and demonstrations simple. Most of the materials suggested in the SEEDS Teacher's Guides are readily obtainable at home or at school. Teachers and / or children should have little difficulty assembling the required materials. Another advantage to the "homemade" approach is that elementary school children more readily relate to and understand experiments involving familiar, everyday objects.

3. Make sure that the children keep the purpose of an experiment firmly in mind as they are conducting it. It may sometimes be advisable to write the purpose on the board for ready reference.

4. It is often helpful to have the children keep a written record, a graph, or a chart of the experiment as it is being conducted. Small drawings of things being observed are also a good way to record information. However, the children should not *always* be required to keep a written record of their experiments, as this may dull their sense of excitement and discovery.

5. Whenever possible, allow the children to manipulate the apparatus themselves, even if they only repeat the experiment or demonstration after you have done it once.

6. Take advantage of situations in which experiments do not follow predicted paths. If this happens (for example, if a plant grows well without air even though the children have learned that plants need air), a *real* problem has arisen. It is not in any sense a "staged" problem. As a result, the children are challenged to think more deeply and plan more wisely. Thus, greater learning may actually take place.

7. Guide the children to apply information gained from experimentation to real-life situations. Your own local situation will suggest ways of doing this. Perhaps the children can help to clean up a vacant lot, thus reducing the effect of garbage on the environment.

8. In your preparation for teaching a particular SEEDS activity, you may wish to carry out a "dry run" of any experiments and demonstrations connected with the activity. In this way you can solve any unforeseen problems beforehand. This may be particularly appropriate if you are teaching at a primary level.

9. You may wish to consider the possibility of filming or video-taping some of the experiments and demonstrations. Children may be interested in making films of themselves performing experiments. Such films could be shown to other classes or to parents on a "parents' day" at school.

Questioning and Class Discussion

Skilful questioning plays an important part in the development of concepts and cognitive skills in the SEEDS program. The following are some of the characteristics of the suggested questions found within the activities in the Teacher's Guides.

1. The questions are clear and specific.

2. They are arranged in carefully planned sequences. They are not asked at random, but in integrated series in order to accomplish specific purposes. Sometimes the purpose of a question series is to refine the children's understanding of certain concepts. Sometimes the goal is to identify and / or review important facts. At other times the purpose of the questioning is to have students apply their knowledge to real or hypothetical problems.

3. There is a balance between fact-oriented questions and questions requiring thoughtful answers. Questions requiring thoughtful answers in the SEEDS program encourage the children to use a variety of cognitive processes, including:

recalling data;

classifying data;

comparing and contrasting data;

showing cause and effect relationships;

giving examples and illustrations;

making and evaluating decisions; and

analyzing or synthesizing facts.

The Story Approach in SEEDS Levels 1—3

Teaching strategies in the primary levels of the SEEDS program include all those used at the higher levels: experimentation, demonstration, questioning, class discussion, group activities, community-based activities, and written work on activity sheets. However, the primary SEEDS levels are different from the others in that they sometimes use narratives to present certain key concepts. These narratives have a number of important functions:

1. They reinforce, enlarge, and supplement the children's firsthand experiences.

2. At the primary levels, stories lay the foundation for more formal learning.

3. They provide the sense of personal involvement so important with young children.

4. They help to vary the pace. This is especially important at the primary levels, where the attention span is relatively short.

5. Stories extend the imaginative powers of children in ways that can help them cope more effectively with everyday life.

6. The SEEDS stories, particularly in Level 1, present role models whose actions the children are encouraged to imitate. (Both adult and child characters in the Level 1 stories are seen helping other people, taking care not to waste food, conserving electricity, and so on.)

7. The story format has the capacity of presenting material that children may not be able to grasp in another form such as group discussion or lecture by the teacher.

8. Stories have a unique capacity for combining the cognitive and attitudinal domains. They present basic facts. They encourage thinking skills. But at the same time they transcend both, adding the important dimensions of feeling, acting, and valuing.

9. Stories at the primary level are useful in providing a synthesis, or meaningful structure, for what might otherwise be just a collection of isolated facts.

10. In an incidental way, the stories in SEEDS contribute to the children's social development and

foster their communication, language, and listening skills.

11. The SEEDS stories are factually accurate and effective in conveying information.

In Level 1, the story "Do What I Do" introduces the idea of human energy as motion. Levels 2 and 3 use stories for such purposes as contrasting natural and artificial environments, illustrating wise and unwise use of trees as a natural resource, and explaining why coal, crude oil, and natural gas are called fossil fuels.

The stories themselves are found within the appropriate Core Activities in the Teacher's Guides. Colorful pictures in the Student Books illustrate the stories for the children. Generally, it is expected that a teacher will read a story aloud, having the children follow the corresponding series of pictures in the Student Book. However, if you have particularly able readers in your class, you may wish to have the students read parts of the stories themselves.

You also might like to put a particular story on tape. If it is a story that contains conversation, as many do, you might enlist some helpers to take the various parts, reading the dialogue aloud for the tape recording. Having the story on tape would free you as the teacher to perhaps point at the pictures in the Student Book as the narrative progresses.

Group Activities

Many of the learning experiences suggested for the SEEDS program involve the children working in groups. This is especially true of the Extension, Enrichment and Investigation activities that follow the basic Core Activities. Small-group activity may sometimes be more difficult to organize and oversee than whole-class instruction. However, group work does have certain distinct advantages:

1. Group activities give children a measure of self-determination and freedom.

2. The development of critical thinking is encouraged by group work. The group must propose various courses of action, rejecting some and choosing others.

3. Working in groups develops the children's organizational abilities.

4. The children practise communication skills, and become aware of effective group processes.

5. Group work fosters a spirit of active cooperation, in which a common goal and group welfare are both perceived as important.

6. Children gain new insights into the talents and abilities of their classmates.

7. Group work is a strategy for making learning more meaningful and immediate, since a group project usually involves the application or transfer of learning that has previously taken place.

Community-based Activities

Two obvious ways of making use of community resources are: inviting visitors from the community to give talks or demonstrations, and taking the children on field trips into the community.

Your school may already have a list of suitable resource persons with differing areas of expertise. Sometimes the children themselves may be able to suggest names of possible visitors. Keep the following suggested guidelines in mind when arranging for a visit by a resource person.

1. Find out ahead of time what specific contribution the visitor can make.

2. Discuss with the visitor your reasons for inviting him or her, the grade level of the children, and a time that would be mutually convenient. It might be wise to suggest to the visitor approximately how long you would like his or her presentation to take.

3. Make sure that the children have the purpose of the visit clearly in mind ahead of time.

4. Make plans with the children regarding how they can get the most out of the visit. It is often helpful to discuss what kinds of questions they might want to ask.

5. After the visit, discuss with the children what they gained from it. Clear up any misconceptions that they may have.

6. Arrange with the children how they may thank the visitor. An individual or group might be appointed to write a short thank-you note. The class might send the visitor drawings or posters made as a result of the visit. If appropriate, you or one of the children might even telephone the visitor to thank him or her.

The following suggestions should help you to plan interesting, valuable and trouble-free field trips.

1. Have a real reason for making the trip. The

trip should be an integral part of the ongoing study, and its purpose should be clearly understood by the children.

2. Make a "dry run" of the trip yourself first in order to determine realistic objectives and identify any problems that could arise.

3. Make the necessary arrangements with: school authorities, owners or authorities in places you intend to visit, parents (secure written consent from parent or guardian for each child), and any individuals who will be helping you with transportation or supervision of the children.

4. Advise the children (and perhaps parents as well) of suitable clothing for the trip.

5. If the children are to make notes, make sure that they take writing materials with them.

6. Discuss with the class suitable conduct and standards of courtesy that should be observed during the field trip. Allow the children themselves to suggest these. You may wish to list them on the board.

7. If the group is large, you may wish to divide the children into "teams." Each team could have a captain who is in charge. The captain might be an older child, a parent, or another teacher who has agreed to help you.

8. If desired, each "team" might be given a specific assignment with regard to things to watch for or information to be gathered during the trip.

9. Don't plan for the children to see too much in one trip. Make sure that you are not rushing them through the trip. This is especially important with primary children.

10. During the field trip, encourage the children to use as many of their senses as possible. For example, they might *listen* for the call of a loon on an outdoor walk. They might *feel* the warmth of sand heated by the sun. On a tour of a bakery, they could *smell* the bread baking. They could even be allowed to *taste* the bread (providing you have arranged for this ahead of time). Of course, the sense they will probably use most is the sense of sight. Encourage them to *observe* carefully and accurately.

11. If brochures or maps or other explanatory materials are available at the place you are visiting, obtain some for later classroom use.

12. Classroom follow-up can take many forms. There should almost certainly be a classroom discussion of the experience and how well it achieved the predetermined purpose. Other possible forms of follow-up would include: oral and / or written reports, field trip booklets or diaries, posters, murals, and repeat visits to investigate aspects the children feel they did not see thoroughly enough on the first visit.

Certain cautions are in order with respect to having children make field trips into natural environments. Such environments can be much more easily damaged than we often realize, as pointed out in the following excerpt from *Nuffield Junior Science, Teacher's Guide 1*, published for the Nuffield Foundation by William Collins Sons & Co. Ltd., London, 1967, p. 268.

"Apart from the dangers created by collecting there is the possibility of damage from thirty to forty pairs of feet. This is generally less harmful to plant life than animal.

"Recently, a study was made of the effect of a group of twenty people walking through a stream with a rocky bottom. The disturbance of the stones by feet resulted in a large haul of animals, mainly stonefly and mayfly nymphs, being caught in nets placed further down the stream. Examination of these disturbed areas showed that they had a reduced population of animals compared to undisturbed area.

"Disturbance of stones in terrestrial habitats can result in the destruction of microhabitats exposing the animals to dangers of desiccation or predation. All stones turned over on the sea shore, land, ponds, or streams should be replaced as nearly as possible in their original position.

"Damage to vegetation may be slight, but for a small group of flowering plants it may mean that flowering cannot take place that season, so there will be a loss of seed this year. Clearly, if this were repeated annually some plants in the area would eventually be destroyed.

"Even slight damage to vegetation may be sufficient to indicate the presence of a nesting bird to a natural predator or suggest its presence to other humans. When we observe nesting birds we must take care not to expose the nest in any way. We must strike a balance between the need to observe and the risks of desertion and predation.

"Occasionally, the interest of the children may, as in a case we know of, when a group of ten-year-old boys wanted to band birds, have to be opposed because they would contravene the laws of the land. It is illegal to capture a bird for observation or banding unless the catcher has a licence to do so. Any such work would have to be done by a licensed specialist who could be called upon to help or take the children on a visit to a local bird observatory.

"One bird observatory run by a group of amateur

ornithologists arranges transport facilities for visiting school parties, and its members demonstrate the varying techniques used. They are most helpful to parties wishing to do general field work in the area surrounding the observatory, but do not allow visits to the rocky shore and sand dune areas during the breeding season of ground nesting birds.

The use of local experts in this way can be of great value both to the teacher and the class. Information about the distribution of rare plants and animals and the areas in which they occur is valuable in deciding suitable areas in which the pupils can work. Clearly such areas should be avoided for general field work."

Review and Evaluation

The progression and continuity of the SEEDS program follow a spiral pattern. It is often impossible to present an important concept fully when first introduced because of the relative immaturity of the children. However, in the SEEDS program, that same concept is presented again within the level, and also from level to level. Each time the concept is presented, the context is somewhat different and the meaning is more completely developed: such an approach helps the children gain an increasing understanding of a core of essential ideas. The use of the spiral approach also constitutes a built-in review mechanism within the program.

In spite of the continual recycling of concepts, you may find on occasion that certain facts and ideas need to be reviewed or retaught.

Evaluation of child learning can take several forms. Particularly applicable to the SEEDS program is the observation of child behavior with reference to specific stated objectives.

Since the learning objectives for each activity of the SEEDS program are specifically stated at the beginning of that activity in the Teacher's Guide, they provide a basis for evaluation. Other important educational goals may be found in the sections on cognitive and attitudinal objectives (pages 24 and 35 of this Professional Reference Guide). Each child should be observed over a period of time, and those observations should be recorded in writing periodically. Such accumulated written observations can serve as a valuable basis upon which to form an opinion about individual child learning.

One should be careful to keep individual differences in mind. What might represent real progress for one child might be less important for another.

Also, it is not enough to be satisfied with mere verbal performance. The emergence of new behaviors in the classroom also indicates that learning has taken place. The following are some examples of acquired behaviors:

1. Showing originality and resourcefulness in research.
2. Finding solutions through reading.
3. Participating in experimentation.
4. Engaging in investigative activities on one's own initiative.
5. Beginning to expect and look for predictability and order in relation to natural phenomena.
6. Distinguishing fact from fancy.
7. Questioning and evaluating sources of information.
8. Withholding judgment until sufficient evidence is available.
9. Demonstrating the ability to be either a leader or a follower, depending on the situation.
10. Showing by actions that one understands and sympathizes with the feelings of other people.

The review activity sheets in the SEEDS program are intended as another criterion for the evaluation of child learning. (However, they should not be used as the only criterion.) These sheets have been designed in such a way that they constitute a learning experience as well as providing a means of assessment. Questions are of several different types, concentrating not only on subject matter but also on thinking skills such as identifying reasons, understanding processes, and making comparisons. In Level 3, questions in the Student Book provide another instrument for assessing the day-to-day acquisition of learning of the children.

Materials

Materials Found Within the Program Itself

As stated earlier, the SEEDS program for Levels 1—6 provides a full range of materials for each level:

1. A comprehensive Teacher's Guide.
2. Student Book that has been designed to stimulate the children's curiosity about energy and the world around them.
3. A series of reproducible Activity Sheets for written work (found at the end of the Teacher's Guide).
4. A sound filmstrip specifically designed to reinforce the concepts and information presented in each of the Levels 1 through 6. Concept framework filmstrips are also provided: one for Levels 1—3 and one for Levels 4—6.
5. A set of Additional Investigations where appropriate.
6. A Professional Reference Guide.

Complete and specific instructions for the use of the materials will be found as one progresses through the numbered activities in the Teacher's Guide. The use of the Student Book, particularly, is quite flexible. Sometimes it is used to introduce a concept. Sometimes it is used as a focus for group work. At other times the Student Book is used to summarize or review what has gone before.

The children are not to write in their Student Books. However, the reproducible Activity Sheets for each level provide for written reinforcement of and response to what has been learned. Of course, at Level 1, the children's work on the Activity Sheets consists mostly of classifying pictures, matching, placing pictures in sequence, and coloring. As the children progress through the level, they are gradually required to use more and more written language.

At the primary levels of the SEEDS program, the use of an Activity Sheet is almost always suggested for the end of a Core Activity (rather than sometime during the course of the Core Activity). One reason for this is that the activity sheets generally provide reinforcement of what has just been learned. Another reason is that primary level children often vary greatly in rate of working and amount of individualized help required. If a teacher has finished the main part of the presentation before handing out the activity sheets, he or she is then free to work with the children on an individual basis as needed.

Specific instructions for the use of the SEEDS filmstrips are found within the numbered activities in the Teacher's Guides. Practical suggestions for the use of filmstrips in general are given in the section entitled "Choosing Supplementary Audio-visual Materials" and "Using Audio-visual Materials," on page 48 of this Professional Reference Guide.

The Additional Investigations provide for direct student involvement through observation and manipulation of materials and / or occurences. Each spins off from the concepts developed within the body of the program.

The Professional Reference Guide provides helpful teaching strategies, as well as background information about the program, and the kind of pedagogy it is based on.

Concrete Materials to Accompany the Program

A recent survey of science teachers revealed that one of the greatest problems they experienced was the difficulty of obtaining materials for scientific experiments and demonstrations. The materials required for experiments and demonstrations in the SEEDS program have been deliberately kept very simple. For the most part, they are the kinds of things that can be easily found in the average school or home. Simple "homemade" apparatus is not only easier to obtain, but also more meaningful

to elementary school children. Such materials help them to see more readily how the concepts they are learning relate to their own immediate environment.

In addition to the materials directly required for experiments and demonstrations, the teacher of the SEEDS program would be well advised to assemble as many other related "real things" as possible. These might include: classroom plants of different kinds, a rock collection, a shell collection, a leaf collection, samples of various kinds of wood, samples of fossil fuels, objects made from fossil fuels, a terrarium, an aquarium, and so on. Of course, many elementary school classrooms already have an abundance of this kind of material. However, the importance of real "touchable" things, or *realia*, cannot be emphasized too much, especially at the primary levels. Some of the many advantages of realia in the classroom are that they:

1. Introduce a variety of stimuli, encouraging the children to use all of their senses—seeing, hearing, touching, tasting, and smelling.
2. Increase and sustain the children's attention.
3. Bring into the classroom events and phenomena that would otherwise remain remote in place or time.
4. Illustrate applications of abstract concepts, and increase their meaningfulness for the children.
5. Can promote a spirit of cooperation and develop a sense of responsibility in the children, especially if their help is enlisted in assembling the real objects and caring for them.

Printed Materials as a Resource for the SEEDS Program

A wide selection of books, pamphlets, pictures, and other printed materials related to energy and the environment should be made easily available to the children if at all possible. A comprehensive collection of such material will help to meet the special needs of individuals. For example, a child might have limited reading ability, but be very much interested in finding out more about coal mining. An "easy" library book on the subject can meet this special need. Another child might have advanced to the stage of putting together a report on a current energy issue. A readily available and up-to-date collection of newspaper clippings can be of great help to this child.

A wide selection of materials allows children to work independently or in small groups, either to complete projects suggested with the SEEDS program or perhaps to carry out their own investigations on matters of particular regional interest. An abundance of available material also helps children to develop the valuable habit of consulting a variety of sources.

Printed materials that would be particularly useful to the children in connection with Levels 1—6 of the SEEDS program include:

1. One or more sets of encyclopedias, preferably well-illustrated and intended for children.
2. Nonfiction, science-oriented books written for children.
3. Atlases and maps.
4. Dictionaries.
5. National almanacs; world almanacs.
6. Leaflets, pamphlets, bulletins, brochures, calendars, charts, posters—often found as free or inexpensive materials from museums, historical societies, conservation organizations, commercial companies and so on.
7. Pictures, photographs, postcards.
8. Children's magazines (some adult-level magazines may also be suitable as reference for Levels 4—6).
9. Relevant newspaper clippings—may be more suitable for Levels 4—6.
10. Locally produced materials—reports on use of energy in your community, guides to wildlife identification in local parks, local histories, and so on.

If you have access to a large central library, you might take out a number of books relating to particular subjects in the SEEDS program. Many communities also have traveling libraries. With advance planning, a selection of appropriate books could be on hand when needed. Sometimes books and other materials can be borrowed from Departments of Education.

A teacher who develops a "collector's eye" can, in the course of everyday life, amass an amazing amount of free and inexpensive printed material suitable for use in the classroom. Children, particularly at Levels 4—6, can assist in finding and organizing such material. For example, they could write letters requesting free government publications, booklets published by various industries, and so on. With teacher guidance they could also

develop an efficient filing system for the collected material.

The following are a few suggestions for the use of supplementary printed materials with the children.

1. Select books and other materials with care. Try to make sure that they give accurate information. If discrepancies arise between books, take advantage of the situation to point out that it is wise to evaluate sources carefully and consult a variety of sources whenever possible.

2. Whenever possible, use reading materials after the children have had firsthand experience. For example, after the children have observed for themselves how wind energy disperses seeds, they may wish to find out more about the subject by reading.

3. Generally, have the children read with specific purposes in mind. Help them to be selective, recording and reporting only the information that is appropriate to their particular investigation or project.

4. Show the children how to use tables of contents, indexes, glossaries, and other reference tools.

Audio-visual Materials for SEEDS 1—6

Eight sound filmstrips accompany the print materials for SEEDS levels 1 through 6; four for levels 1—3 and four more for levels 4—6. Each group of four includes a concept framework or "overview" filmstrip and a level-specific strip for each of three grade levels.

These filmstrips were developed as an integral part of the SEEDS program: the core ideas in the print materials are also presented and developed in the filmstrips.

Because each concept framework filmstrip is intended for use with three different grade levels, there is a planned repetition and overlap of concepts from this strip to each level-specific strip. This repetition is an important part of the spiral pattern of concept development. A given concept is presented in its simplest form in the concept framework filmstrip, then elaborated upon or presented in its broader context in the level-specific filmstrips as content requires.

In some instances, a short sequence from a filmstrip may also serve to introduce or review a topic. In either case, these situations have been underwritten in the teacher's guides with information about the specific frames to be used.

The visuals in all eight filmstrips are predominantly photographic, to heighten the "real-life" applicability of the topics being presented. When the content of a frame was as specific as a girl using a bicycle generator to light the headlight for her bicycle (frame 11 in **Energy: How We Change It**), a photograph was specially commissioned. Other photographs were selected from a variety of stock collections on the basis of content suitability and visual quality.

When photographs were not available, for example, of a prehistoric swamp; of the strata beneath the earth's surface showing the location of coal, oil, or natural gas; or of the understructure of an offshore drilling rig, drawings were prepared. Drawings were also used to depict the energy sources and energy uses of people living a hundred years ago. These particular drawings help to reinforce the distinction between the world as children experience it and as it can be photographed and the world of yesterday.

What follows is a brief explanation of the content and applications for each series of four filmstrips; what they are about, and where and how they can best be used.

SEEDS 1, 2, and 3

In the filmstrips for Levels 1—3, the emphasis is on the energy we depend on all the time. The basic concepts are: our personal energy and where we get it; the difference between our energy needs and the energy needs of machines; renewable and nonrenewable energy sources; and the ways in which we can learn to save energy and use it wisely.

Concept Framework Filmstrip
Energy Everywhere

This filmstrip introduces the concepts developed in these three levels. It is used at the end of Level 1 to reinforce the learning that has taken place, and at the beginning of Levels 2 and 3 to review the concepts developed in the earlier grades.

Level 1

Activity 6
Food Energy or Gasoline Energy?
• frames 1–24 from **Energy Every Day** review and reinforce concepts presented in the first five activities

Activity 14
Energy Flow Through Food Chains
• frames 25–36 from **Energy Every Day** review food chains and the interdependencies that exist within them

Activity 20
What Have You Learned About Energy
• entire concept framework filmstrip **Energy Everywhere** used to help students formulate their answers to this question

Level 2

Activity 1
Energy: What Is It? Where Can We Find It?
• concept framework filmstrip **Energy Everywhere** used to summarize concepts presented in Level 1

Note: Frame references in the following activities refer to the level-specific filmstrip for Level 2, **Energy from Wind, Water, and Wood**

Activity 3
Can Energy Be Renewed?
• frames 1–19 introduce wind, water and wood as sources of energy

Activity 5
Using Wind Energy
• frames 20–24 review concept of the wind cycle and wind as a source of energy

Activity 7
Using Energy from Moving Water
• frames 25–32 review the water cycle and water as a source of energy; the dependence of wind and water cycles on the sun; wind and water as renewable energy sources

Activity 11
Using Wood Energy Wisely
• frames 33–37 review concepts of energy from wood presented in Activities 9 and 10

Activity 15
What Have You Learned About Energy
• entire filmstrip reviews topics developed in this unit

Level 3

Activity 1
Energy Everywhere
• concept framework filmstrip used as per Activity 1 in Level 2

Note: Frame references in the following activities refer to the level-specific filmstrip for Level 3, **Energy from Fossil Fuels**

Activity 7
Getting Fossil Fuels Ready for Use
• frames 25–32 explain methods used to transport coal, oil, and natural gas from sources to places in which they are used

Activity 8
Fossil Fuels and the Environment
• frames 19–24 discuss fossil fuels and the impact the methods of extraction from the ground have on the environment

Activity 10
Fossil Fuels are Nonrenewable
• frames 1–10 review renewable energy sources and distinguish between renewables and nonrenewables

Activity 11
Use Fossil Fuels Wisely
• frames 34–41 discuss ways in which we can use energy wisely

Activity 15
What Have you Learned about Fossil Fuels?
• entire level-specific filmstrip used as per Activity 15, Level 2

SEEDS 4, 5, and 6

The filmstrips for Levels 4—6 examine the many sources of energy available today. The basic concepts presented are: what energy is; the energy sources we use; the environmental and societal problems that the extraction, conversion, and use of these energy sources can cause; the advantages and disadvantages of renewable and nonrenewable energy sources; and the ways in which we can learn to use energy wisely.

Level 4

Activity 2 Sources of Energy
• concept framework **Energy: The Sun** used to introduce students to the source of energy we use the most

Activity 6 Web of Life
• frames 30–35 of level-specific strip **Energy: How We Get It** introduce the concept of the interdependence of elements within our natural environment

Activity 8 Energy from Water
• frames 19–24 from concept framework introduce the water cycle and the role the sun plays in it

Activity 9 Energy from Wind
• frames 15–19 from concept framework introduce the wind cycle and concept that energy from wind can also be harnessed

Activity 12 Oil: Getting it out of the Ground
• frames 13–20 from level-specific strip introduce methods used to extract oil from the ground

Activity 14 Coal: Getting It out of the Ground
• frames 21–25 from level-specific strip introduce underground and strip mining, the methods used to extract coal

Activity 18
Energy: How We Get It
• entire level-specific strip used as per final activity in Level 3

Level 5

Activity 1
Energy: Its Many Forms
• concept framework **Energy: The Sun** used to summarize concepts presented in Level 4

Note: Frame references in the following activities refer to the level-specific filmstrip for Level 5, **Energy: How We Change It.**

Activity 4
Waterwheels, Windmills, and Turbines
• frames 1–12 introduce the concept of harnessing the energy from water and wind

Activity 5
From Coal to Kilowatts
• frames 15–21 review the process by which heat energy produced by burning coal, oil, or natural gas can be converted to electricity

Activity 12
Oil Refining and Our Environment
• frames 22–31 introduce concept that although electricity is a clean energy source to use, its production methods can create polluted environments

Concept Framework Filmstrip Energy: The Sun

This filmstrip introduces the concepts developed in these three levels. It is used several times throughout Level 4 to introduce topics or reinforce learning that has taken place. It is also used at the beginning of Levels 5 and 6 to review the concepts developed in earlier grades.

Activity 14
Oil: The Amount We Use
• frames 36–44 review concept that although we depend on energy converted from fossil fuels we must try to use these fossil fuels more wisely, to convert them more efficiently, in ways that maintain our environment

Activity 18
Energy: How We Change It
• entire level-specific strip used as per final activity in Levels 2, 3, and 4

Level 6

Activity 1 Energy: Its Uses
• concept framework strip **Energy: The Sun** used as per Activity 1 in Level 5

Note: Frame references in the following activities refer to the level-specific filmstrip for Level 6, **Energy: How We Use It.**

Activity 7
Waste Not—Want Not
• frames 7–25 summarize the differences in the lifestyle of people a hundred years ago and the lifestyle we enjoy today

Activity 11
We Should, But Will We?
• frames 26–55 review topics discussed thus far as well as introduce topics that follow

Activity 19
Energy How We Use It
• entire level-specific strip used as per final activity in Levels 2, 3, 4, and 5.

Choosing Supplementary Audio-visual Materials

The SEEDS program offers a filmstrip for each level, and also concept framework filmstrips covering Levels 1—3 and Levels 4—6. Other useful filmstrips, as well as slide presentations and motion pictures, are available from a variety of sources. However, these do need to be carefully chosen if they are to achieve the desired objectives. They should be appropriate to the ages of the children. This is particularly important at the primary levels. Any supplementary audio-visuals should also be accurate and should present sufficient data for the development of concepts. There should be a balanced presentation of data and viewpoints. One should watch this particularly with audio-visuals produced by special-interest groups such as commercial companies or advocates of very different alternative lifestyles.

If you have specialized knowledge in a particular area or access to special equipment or settings, you may wish to consider making some audio-visuals of your own. For example, if you are able to visit a site where oil sands are being mined, you might wish to make a slide presentation or filmstrip of the process. Other teachers in your school may have personal slide collections or movie films that could prove useful. Children themselves may be able to participate in photography and filmmaking, particularly at Levels 4—6.

Using Audio-visual Materials

The following are some general guidelines for the use of filmstrips and other audio-visuals with the SEEDS program:

1. Always store filmstrips at room temperature. If filmstrips are used when they are hot, they will stretch. If they are cold, they will become brittle and break.

2. Always preview the audio-visual before using it with the class. You might do this alone, with other teachers, or perhaps with a small committee of children. Plan how the audio-visual will be used, referring to the film guide if there is one.

3. Prepare the class. Discuss with them the reasons for seeing the film. Give them some main points to watch for, helping the children to separate the important from the unimportant. Present any difficult vocabulary used in the film if you feel this is necessary. List any questions that the children would like to have answered through the viewing of the film.

4. After the children have seen the film, discuss it with them to see what they have learned from it. Discuss whether the film answered the questions that the children posed beforehand.

5. Do not expect too much from one showing of a film. At least two showings of a particular film are often advisable. As occasionally suggested in the SEEDS Teacher's Guides, you may wish to show the film without the sound the second time. This will allow you and the children to discuss the film as it progresses. It can also be a technique for evaluating learning if you ask questions or have the children supply the commentary.

6. In order to involve the children even more, you might like to have them record, in groups, their own version of the audio portion of filmstrips. In relation to the SEEDS filmstrips in particular, you might like to have them emphasize what they and the community could do to combat waste, pollution, and environmental damage.

7. Sometimes a follow-up activity may be appropriate. This might take the form of a written or oral report, creative writing, research, preparation of pictures or charts, role-playing, or dramatization.